U.S. Army Corps of Engineers
Nashville District

ENVIRONMENTAL ASSESSMENT

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Lake Barkley and Kentucky Lake
Tennessee/Kentucky
Summer Pool Extension Evaluation

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TABLE OF CONTENTS

TABLE OF CONTENTS

Section **Page**

List of Appendices

List of Tables

List of Figures

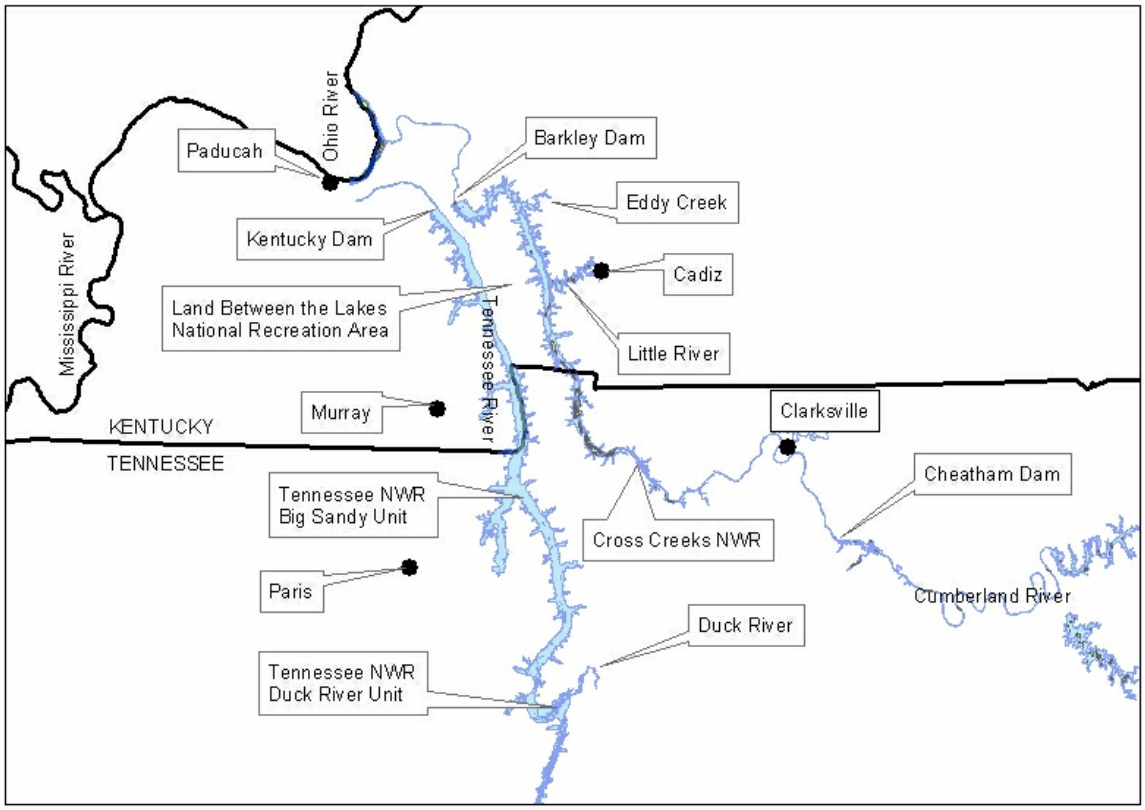
Environmental Assessment

Section 1.0 Introduction. The U.S. Army Corps of Engineers (Corps) has been requested to consider a proposal to change pool levels at Lake Barkley that, by its association with Kentucky Lake through an unregulated canal, ultimately affects pools at Kentucky Lake. The Nashville District of the Corps of Engineers and the Tennessee Valley Authority (TVA) are preparing an Environmental Assessment (EA) to address this proposal. Lake Barkley is a Corps of Engineers lake completed in 1966 on the Cumberland River in western Kentucky and middle Tennessee. The lake is formed by a dam at Cumberland River mile (CRM) 30.6 with the navigation pool extending to Cheatham Dam at CRM 148.7. Kentucky Lake is a TVA impoundment in western Kentucky and Tennessee and is formed by a dam on the Tennessee River at mile (TRM) 22.4. Its navigation pool extends to Pickwick Dam at TRM 206.7. Since both lakes are connected by the unregulated Barkley Canal, they are operated in tandem and any changes to operation must be approved by both agencies. Both lakes are operated primarily for flood control, hydropower, and navigation as well as secondary purposes of recreation, water quality, water supply, and fish and wildlife habitat. Figure 1 is a vicinity map showing both lakes and local communities and other points of interest.

Section 2.0 Purpose and Need For Action. The Corps was requested to consider improving recreational boating conditions in the lakes by extending summer pool (elevation 359 feet) from the current drawdown date of July 1 until July 15. This requires a change in the guide curve governing lake regulation. A verbal request was made by Congressman Ed Whitfield (KY-01) during a meeting with Corps officials on February 25, 2005. Congressman Whitfield requested a written response concerning extending summer pool until July 15. The Corps' response (letter dated March 18, 2005) is shown as Item 1 of Appendix 1. This letter stated that an EA under the National Environmental Policy Act would need to be completed prior to implementing any "trial" pool changes. This EA documents the evaluation to date and discusses future courses of action.

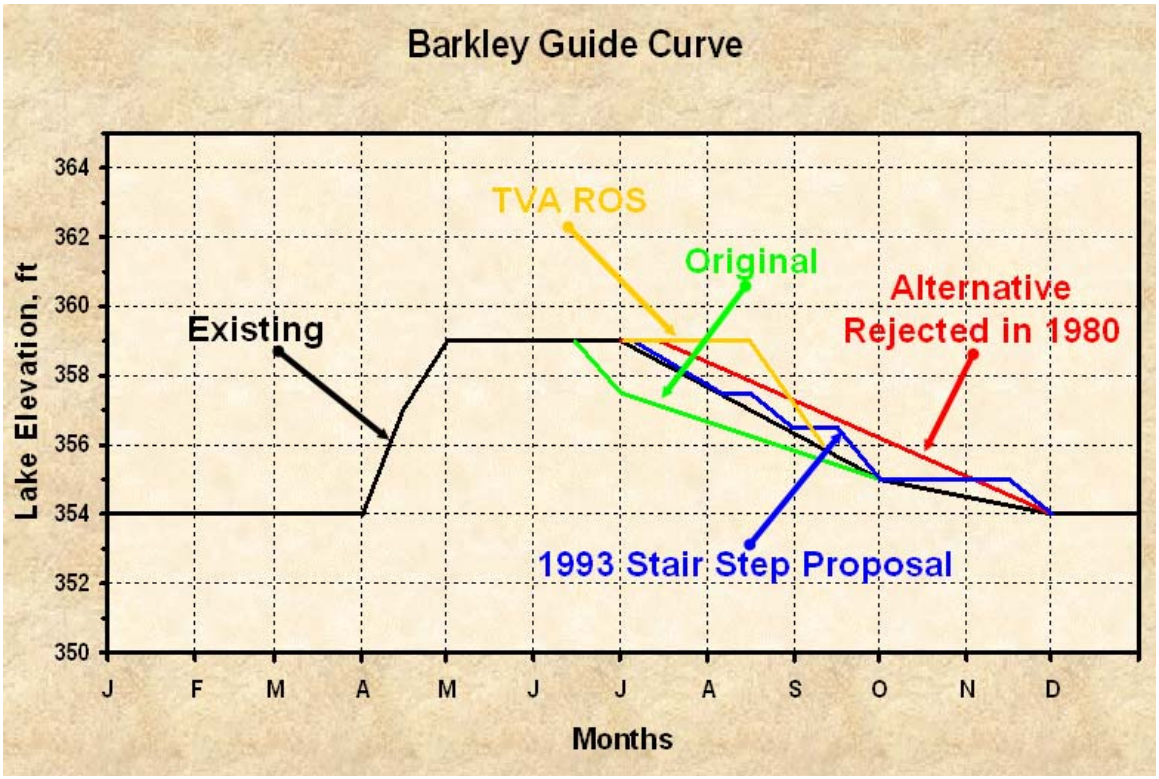
2.1 Background. This latest request is similar to requests that have been periodically made over the years. In 1966, the lakes were connected by the unregulated Barkley Canal to allow boats to pass between the two lakes. With the construction of the canal, Lake Barkley has been operated in an identical manner as that of Kentucky Lake. Figure 2 shows the variety of guide curves that have been implemented or formally considered over the years. The original guide curve (shown in green) had a winter pool of 354' until March 31, and then the lake was filled to reach summer pool (359') by May 1. Summer pool was held until June 15, then the lake was lowered (for mosquito control) to elevation 357' by July 1, then gradually lowered to return to winter pool by December 1. Figure 2 also shows the existing guide curve (in black) that was implemented in 1980. This operation allows flood control storage to be available at the time of year when flood events typically occur (winter and spring months), although large flood events can occur year-round. The top of the flood control pool is elevation 375'.

Figure 1: Vicinity Map



In 1977, the Corps and TVA held a meeting at the request of officials of Kentucky's Western Waterlands, Marshal County Chamber of Commerce, State of Kentucky and State of Tennessee to discuss modifications to the guide curve. The drop in the guide curve in late June was viewed as a boating safety problem and higher water levels at other times were also requested for recreational benefits. The Corps and TVA agreed to review operations to see if recreation could be improved. An EA was completed by the Corps in 1985 which documents consideration of three guide curves and implementation of a trial guide curve (now the existing curve) between 1980 and 1985. The existing guide curve was recommended by TVA and first implemented in 1980. It called for an additional 15 days of summer pool (June 15 to July 1) and a return to the original guide curve by the end of September. The purpose of this change was to provide additional recreational benefits, primarily for fishing, and at the time was supported with some reservations by the various resource agencies. In 1984, the Corps and TVA formally adopted a modified guide curve with the official drawdown date being July 1. An unofficial drawdown date of July 5 was later implemented to allow higher water levels over the July 4 holiday. Also considered in the 1985 EA was an alternative proposed by the Corps (shown in Figure 2 in red) but it was rejected due to concerns about adverse impacts on several wildlife refuges and waterfowl programs.

Figure 2
Variety of Guide Curves Implemented or Considered at Lake Barkley



Additional pool operations have been proposed and implemented for short trial periods. In the early 1990's a Stair Step drawdown (shown in Figure 2 in blue) was proposed by several resource agencies. It was agreed that a three-year trial period would be attempted with data to be collected by various resource agencies during the trial to evaluate the benefits and impacts of the Stair Step drawdown. The actual trial operation was attempted during 1990-1994 but it was interrupted by high flow events/droughts for some years. During the two years it was successfully implemented, concerns were raised about the negative affects of extended summer pools on shoreline vegetation and fisheries. At the request of the resource agencies, the Stair Step operation was ceased and the lake has since been operated according to the existing guide curve shown in black in Figure 2 (agreed upon date of July 5th drawdown). Other operational constraints for flood or drought conditions are discussed elsewhere (refer to Sections 4.1, 4.11, and 4.12).

The purpose of this EA is to provide National Environmental Policy Act (NEPA) consideration of the proposed federal action, which is the Corps formally modifying pool levels during a trial period by holding summer pool an additional 15 days (i.e., until July 15 only). It is assumed the pool would return to the existing guide curve at some unspecified date (assumed to be between August 1 and 15 under normal flows) after July

15 by aggressive generation of hydropower and not by releases through the spillway gates except during high flow periods. This EA was prepared pursuant to NEPA, Council of Environmental Quality (CEQ) Regulations (40 CFR 1500-1517) and the Corps implementing regulation, Policy and Procedures for Implementing NEPA, ER 200-2-2, 1988. The Corps is the lead agency and TVA is a cooperating agency on this EA. TVA also complies with NEPA through the CEQ Regulations and TVA's own procedures implementing NEPA. At the conclusion of the EA, the Corps and TVA would make a determination that either a Finding of No Significant Impact (FONSI) is appropriate for the proposed pool extension or that a comprehensive Environmental Impact Statement (EIS) would be required before making any pool changes.

2.2 Incorporation By Reference. In 2004, TVA completed a comprehensive review of operations on the TVA reservoir system, *Final Programmatic Environmental Impact Statement, Tennessee Valley Authority Reservoir Operations Study* (February 2004) ("ROS EIS"). The Corps was a cooperating agency in the ROS EIS. This current EA would tier from the ROS EIS in order to utilize previous analysis and information. It is noted that summer pool extensions considered in the ROS EIS were longer in duration than the current proposal (refer to Figure 2, yellow curve). With regard to the two lakes, the ROS EIS determined that no summer pool extensions would be implemented due to concerns about environmental and flood control impacts. Also, as another commitment of the ROS EIS, TVA committed to developing better benchmark data about wetland plant communities and shorebird and waterfowl habitat on Kentucky Lake (refer to ROS EIS, page 7-11). This benchmark data is critical in evaluating effects of any pool changes; data collection began in 2005 and will continue through 2009. The Corps is performing similar benchmark data collection on Lake Barkley. The Corps would honor this benchmark data collection and no trial pool change would be proposed until that benchmark data is collected.

In accordance with CEQ regulations, 40 CFR Chapter V Section 1502.21, the following NEPA documents are incorporated by reference: 1) the TVA ROS EIS and 2) the Corps' EA titled Water Level Stabilization Lake Barkley (May 1985). Pertinent information is summarized from these documents to provide an understanding of the current evaluation of proposed alternatives. Duplication of previous information is minimized as much as possible. Copies of each document are available from TVA or the Corps, at the addresses shown on the title page. The ROS EIS is also available at http://www.tva.gov/environment/reports/ros_eis/index.htm.

Section 3 Alternatives Considered and the Corps' Recommended Alternative.

3.1 Introduction. Following the Corps meeting with Congressman Whitfield in February 2005, the Corps' written response was provided to both the Congressman and TVA. TVA responded with a letter dated April 1, 2005 (refer to Appendix 1, Item 2) which agreed with the Corps determination that an EA was required before implementing any trial operation and raised concerns about interference with TVA's baseline data collection effort. The latter was a commitment from the ROS EIS.

Both TVA and the Corps agreed that a meeting should be held with the resource agencies that had voiced concerns over pool extensions during the ROS EIS. This meeting was hosted by the Corps on April 3, 2005 and a copy of the meeting minutes are shown in Appendix 1, Item 3.

One issue discussed was implementation of a trial pool change in conjunction with an intense data collection effort. A trial could be conducted under a categorical exclusion per Corps regulations, paragraph 9c of ER 200-2-2 (Policies for Implementing NEPA for Corps Civil Works Program), which allows technical studies that do not require funding for construction, taking into account consideration of environmental matters. However, the above policy also states that categorical exclusions should not be applied if there are extraordinary circumstances that may dictate the need for an EA or EIS. Several concerns were discussed in the meeting including the lack of adequate baseline data for which to compare effects of any trial and impacts of past pool changes on shorebirds, waterfowl, fisheries, wetlands, and shoreline erosion.

The Corps requested that each agency provide a letter documenting its concerns and existing data on past impacts. These letters are included in Appendix 1 as Item 4 (U.S. Fish and Wildlife Service (USFWS) –Tennessee National Wildlife Refuge Complex, dated May 9, 2005), Item 5 (Tennessee Wildlife Resources Agency (TWRA), dated May 11, 2005), Item 6 (USFWS-Tennessee Field Office, dated May 19, 2005) and Item 7 (Kentucky Department of Fish and Wildlife Resources (KDFWR)), dated June 10, 2005. The KDFWR later modified its position (refer to the next paragraph). Because of the obvious environmental concerns, a categorical exclusion could not be applied and the trial operation was delayed until completion of an EA and a determination that a FONSI statement could be signed by both the Corps and TVA. After discussing these concerns with Congressman Whitfield's Office, the Corps decided to proceed with preparation of an EA.

Preparation of an EA would allow wider consideration of the proposed summer pool extension and allow a more diverse set of interests to be represented. The formal EA process was initiated with the distribution of a Scoping Notice soliciting comments on this issue as well as recommendations on alternatives to be considered. A copy of this notice is included in Appendix 2 as Item 8. The initial scoping notice mailing list was developed from the Lake Barkley marinas and TVA's ROS EIS address lists for the Kentucky Lake area. Additional agency responses received during scoping were provided by KDFWR, the U.S. Forest Service Land Between the Lakes, and the Corps'

Mississippi Valley Division Office (Items 9-11). The KDFWR modified its previous position by a letter dated March 3, 2006 stating that all proposed pool changes be fully evaluated as part of the NEPA process. Responses to the scoping notice and letters forwarded by others on this issue are included in Appendix 2 as Items 9-28 (refer to Section 3.3).

3.2 Alternatives. Alternatives being considered in detail in this EA are No Action and the Proposal to hold summer pool until July 15 with aggressive return to the existing guide curve through hydropower generation (by August 15).

3.2.1 No Action. Under the No Action alternative, the lakes would be operated under the currently approved guide curve with the drawdown date being July 1 (unofficially after the July 4 holiday weekend). This has been the operation since initial trials began in 1980 and is shown in Figure 2 in black. The Corps and TVA informally decided to extend the summer pool through the July 4 holiday weekend to allow full pools to continue during this high recreational use period. In reality, the existing drawdown guide curve is shown in Figure 3 in green.

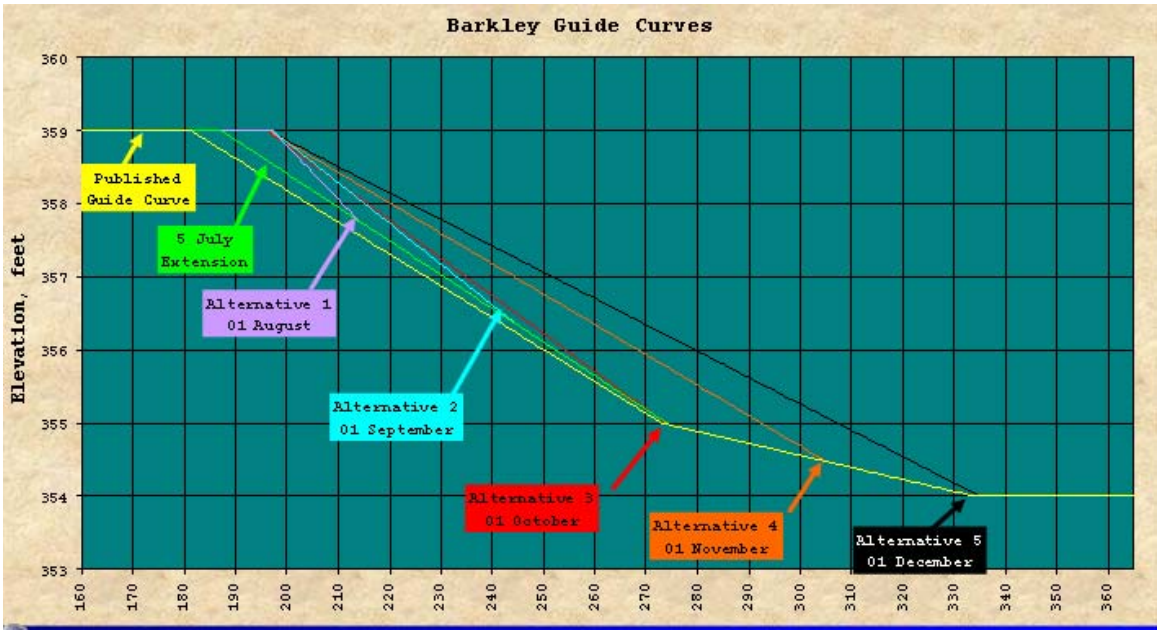
3.2.2 Proposed Action (Summer pool until July 15). Under the proposed action, for a trial period of three years, summer pool would be maintained until July 15 then gradually returned (through aggressive hydropower generation) to the existing guide curve between August 1 and 15. The primary purpose of this action would be to improve recreational boating conditions during the period of raised pools. This operation is shown on Figure 3 in purple for a return date of August 1. The term "trial operation" means that any future pool changes would be done for the trial period (at least 3 years). At the end of the trial, another NEPA assessment would be performed considering data collected during the three year trial period before finalizing any guide curve change.

3.2.3. Other alternatives were proposed during scoping and agency coordination but are not considered in detail in this EA. These alternatives are briefly discussed below but were considered beyond the scope of this EA. They would have obvious significant impacts, therefore, detailed evaluation was deferred but could be reconsidered if the decision was made to conduct a more comprehensive analysis of impacts during preparation of a possible future EIS.

3.2.3.1 Original Guide Curve. At the request of some of the resource agencies, a return to the original guide curve should be considered. Under this operation summer pool would be maintained only until June 15, this operation is shown in green in Figure 2. The purpose of this operation would be to improve habitat features that were adversely impacted by the previous changes including shoreline vegetation, fisheries, and migratory bird habitat. This alternative would have major impacts on summer recreational boating and economic considerations that are related to summer boating and lake front property.

3.2.3.2. Additional Extension Past July 15. Both prior to and in response to scoping for this EA, additional pool modifications were proposed that would raise pool levels above the current guide curve for longer periods in the year. Under these operations,

Figure 3
Proposed Guide Curves with Summer Pool Held Until July 15 and Various Return Dates to the Existing Guide Curve



Julian Date (period of June 9 to December 31)

pools would be above the guide curve for various lengths of time ranging from after Labor Day to December 1. The purposes of these proposed changes would be to provide better boating conditions, improved conditions for lake front properties and additional tax revenues for counties affected by raised property values. This alternative would have potentially significant adverse impacts on hydropower and flood control and navigation downstream of the two dams and on critical environmental (mudflats, vegetation, refuges, endangered species, water quality) and economic (hydropower, fishing/hunting revenues) resources in the two lakes.

3.3 Scoping responses. Appendix 2, Item 29 is a summary of comments received by December 20, 2005 in response to the scoping notice. One additional letter from the KDFWR was subsequently received on March 3, 2006. Two general opinions were voiced. One view was in favor of pool extensions, most called for additional extensions well into the fall. These opinions were generally based on benefits to boating, local recreational economy, and near-lake property values. The other view was opposed to any pool changes except for reverting to the original guide curve. These opinions were generally that impacts to wetland plant communities, shorebirds, waterfowl and fisheries habitat were not warranted by any extensions. All scoping responses are shown in Appendix 2 (Items 9-28), names and addresses of private individuals have been removed.

3.4 Corps Recommended Alternative. Based on the environmental consequences discussed in Section 5 of this EA, an extension of summer pools at Lake Barkley and Kentucky Lake would have potentially significant environmental impacts; therefore, a

determination was made that a FONSI could not be signed. The existing operation (No Action) seems to provide a balanced approach for handling the various demands on the two lakes. The existing drawdown date is not ideal for environmental considerations but appears to be marginally acceptable. The proposed action would provide some additional recreational benefits, but these improvements do not appear to be justified when balanced against the environmental consequences of extending the date for beginning the drawdown to July 15.

There does appear to be potential for localized projects such as small-scale dredging or improvements to existing recreational facilities that might improve existing usage without extending summer pool levels. Other actions to improve boating usage include better mapping and marking of channels and hazards. The Corps and others are discussing changes that can be made without pool operation modifications. Once identified, these would be evaluated under NEPA on a case-by-case basis. Some actions may be covered by existing NEPA documents and require no additional NEPA evaluation. Potential actions could be proposed by either the Corps or private entities.

If any pool extensions are pursued, a detailed EIS needs to be prepared due to potentially significant effects. If an EIS is prepared, analyses would consider an appropriate range of reasonable alternatives, including pool extensions of longer duration as well as reverting to the original guide curve. Mitigation efforts and costs associated with each alternative considered in detail would also be developed in any EIS (also refer to Section 8.4 for additional discussion on mitigation). One issue with performing such analysis for an EIS is funding for the study costs. As an example, detailed evaluation of downstream flood risks and better characterization of net economic benefits are needed. Current Corps budgets do not include those costs. Further complicating any changes is the on-going baseline data collection efforts by TVA and the Corps. The duration of these data collection efforts, which began in 2005, is three to five years. Baseline data documentation is needed in order to allow a definitive assessment of any future trial operations. Preliminary study costs for an EIS, including flood risk and ecological studies, is on the order of $2-3 million. This is currently not included in any near term Corps budget.

3.5 Environmental Compliance. Table 1 shows various environmental laws, regulations, and executive orders that appear applicable to the proposed action. The level of compliance shown in the table is based on the current level of compliance after conclusion of this EA if the proposed action were pursued.

On March 20, 2006, the Assistant Secretary of the Army for Civil Works signed a Memorandum of Understanding detailing collaboration between the National Audubon Society and the Corps of Engineers. The Memorandum of Understanding calls on the two organizations to:

-- Encourage water management measures that benefit migratory and resident native birds, other wildlife, plants and natural communities while meeting human needs;

-- Foster wetland protection and restoration and demonstration projects to test promising innovative water management strategies;

-- Promote the gathering and sharing of scientific data and research; and

-- Cooperate in public information and education efforts.

The recommendation of this EA is in accordance with this MOU.

Table 1. Environmental Requirements and Protection Statutes and Level of Compliance Associated with the Proposed Action at this Point of NEPA Review

Environmental Requirement	Level of Compliance[1]
Federal Statutes	
Endangered Species Act as amended, 16 U.S.C. 1531, et seq	NC
Fish and Wildlife Coordination Act as amended, 16 U.S.C. 661, et seq.	PC
National Environmental Policy Act as amended, 42 U.S.C. 4321, et seq.	PC
National Historic Preservation Act as amended, 16 U.S.C. 470a et seq.	FC
Rivers and Harbors Act, 33 U.S.C. 403, et seq.	NA
Watershed Protection and Flood Prevention Act 16 U.S.C. 1001, et seq.	NA
Clear Air Act as amended, 42 U.S.C. 7401, et seq.	FC
Clean Water Act as amended, 336 U.S.C. 1251, et seq.	FC
Executive Orders, Memoranda, etc.	
Floodplain Management (E.O. 11988)	PC
Protection of Wetlands (E.O. 11990)	NC
Farmland Protection Policy Act, PL 97-98, 7 CFR 658	PC
Environmental Justice (E.O. 12898)	PC
Migratory Birds (E.O. 13186)	NC
Invasive Species (E.O. 13112)	PC

[1]*FC-Full Compliance, NA-Not Applicable, NC-Non Compliance, PC-Partial Compliance*

Section 4.0 Affected Environment.

4.1 Introduction. For the purposes of this EA, a brief discussion of pertinent resource categories is provided. Pertinent resources are those that would be most likely affected by the proposed action. The proposed action is the extension of summer pool from July 5 to July 15 followed by some return period to the existing guide curve through hydropower generation. For discussion purposes, this return period is assumed to be two to four weeks; therefore, pool levels would be above the existing guide curve for the month of July through mid-August.

The TVA ROS EIS provides a detailed discussion of resource categories for the affected environment, including general characteristics for mainstem reservoirs such as Kentucky Lake and Lake Barkley. In addition, specific data is provided for Kentucky Lake and, to a lesser degree, Lake Barkley in the ROS EIS. This information is incorporated by reference in this EA with key discussions repeated in this EA where pertinent.

The following resource categories are discussed in this section as they are most likely to be affected by the proposed summer pool extension:

- Water Quality;
- Aquatic Resources, including lake and tailwater fisheries and mussels;
- Wetlands;
- Terrestrial Ecology, including mudflats, lowland and shoreline plant communities, and shorebirds;
- Threatened and Endangered Species;
- Managed Areas, including National Wildlife Refuges;
- Shoreline erosion;
- Cultural resources;
- Visual Resources, including mudflats and wildlife viewing;
- Flood Control, both in lake and down river;
- Navigation, downstream of the two dams;
- Hydropower generation;
- Recreation;
- Social and Economic Resources.

Physiography. Lake Barkley is located in the Highland Rim (Mississippi Plateau) physiographic region. Kentucky Lake is located in the Highland Rim and Coastal Plain (Mississippi Embayment). Kentucky Lake has a local drainage area of 4,600 square miles (11,900 square kilometers) in seven counties of Kentucky, thirteen counties in west and middle Tennessee, and one county in Mississippi. Lake Barkley has a local drainage area of 3,438 square miles (8,904 square kilometers) from eight counties in west Kentucky and seven counties in northern middle Tennessee.

Reservoir Systems. Both lakes are the most downstream of multi-project reservoir systems. Lake Barkley, completed in 1966, is the most downstream of ten reservoirs in the Cumberland River basin, nine of which are operated in a systematic manner. It is also

one of four commercial navigation projects on the Cumberland River. One key consideration is the storage available in both lakes and how this flood control storage plays a role in managing downstream conditions on the lower Ohio and Mississippi Rivers. During critical flood or drought periods on the downstream rivers, releases from both Kentucky and Barkley Dams are managed by the Corps' Great Lakes and Ohio River Division Office in Cincinnati, Ohio, in close coordination with the Mississippi River Division Office in Vicksburg, Mississippi. The primary objective in operating Kentucky and Barkley Lakes for flood control is to preserve and protect the Mississippi River levee system as stated in the joint TVA/Corps operating manual. Operations during flood or drought periods are discussed in more detail in Sections 4.11 and 4.12. From a reservoir operations standpoint, the affected environment includes the reservoirs themselves, as well as the lower Tennessee and Cumberland Rivers, lower Ohio River and Mississippi River downstream of Cairo, Illinois to New Orleans, Louisiana.

The topography of the area resulted in lakes with meandering channels with very shallow bars adjacent to the channel. Mudflats, shallow bars, and islands are common in the lower half of the reservoirs. The shallow slope of most mudflats results in large areas being inundated at summer pool levels and dewatered at winter levels. A marked commercial navigation channel with a minimal depth of 9 feet is maintained through the lakes.

4.2 Water Quality. The ROS EIS and various Corps water quality reports discuss water quality conditions in the two lakes. Water quality conditions in these two lakes are generally controlled by upstream dam releases which determine residence time through the lake. During times of isolated local precipitation, local inflows can create slugs of poorer quality water in the lakes. Each lake contains a riverine section in the upstream reaches where the pool is generally confined to the original river channel. This is followed by a long transition from riverine to more lacustrine (lake-like) conditions in downstream progression.

In general, water quality conditions in the lakes are acceptable due to the relatively weak thermal stratification which helps maintain dissolved oxygen (DO) levels in the deeper waters. During times of higher flow (and shorter residence times), DO depletion does not progress to the point where hypolimnetic (bottom) DO levels are low. As flows decrease and residence times increase, the effects of thermal stratification are more apparent and DO can become depleted in the lower reaches of Lake Barkley. Residence times during summer months generally can range from 10 to 45 days depending on flow conditions in the reservoir systems. Hypolimnetic DO is commonly low (0-3 mg/l) from the confluence of the Little River to the Barkley Canal (26 miles). Some recovery occurs below the canal due to a general inflow of surface water from Kentucky Lake.

Water quality conditions of embayments are generally poorer due to higher algal levels, stronger thermal stratification, and absence of DO below the epilimnion (surface layer). Embayments are somewhat isolated from the main channel and develop more severe water quality conditions. They can also receive high nutrient loads from the local watersheds during times of local runoff. The main channel of Lake Barkley is considered

mesotrophic (moderate nutrient levels and algal productivity) while embayments are eutrophic (high nutrients levels and algal productivity). The buildup of anoxic products due to exposure of bottom sediments to low DO is generally not a problem.

Releases from the two dams generally have good water quality. Releases from Barkley benefit from inflows through the Barkley Canal from Kentucky Lake. Occasional violations of the DO water quality standard (< 5 mg/l) have been noted in data from site visits and a continuous water quality monitor. More numerous readings are noted below 5.5 mg/l, indicating the sensitivity of the lake to thermal stratification effects. During periods of spilling from the dams, gas supersaturation can lead to fish kills below the dams. This is more of an issue below Kentucky Dam where fish kills have occurred in the past. TVA minimizes this affect by operating spillway gates in a sequenced manner in an attempt to keep gas levels from reaching problem levels below the dam.

The key controlling water quality factor is inflow from upstream projects which determines residence time. As residence time increases, water quality conditions generally decline and is reflected in lower DO, higher anoxic products, and higher chlorophyll *a* levels.

4.3 Aquatic Resources. Aquatic resources for Kentucky Lake are described in the ROS EIS and summarized here. Benthic macroinvertebrates and water chemistry are also periodically monitored at several points in Lake Barkley. Benthic macroinvertebrate communities are considered fair in the forebay region and good in mid-reservoir. The inflow section of the lake is rated as fair. In general, they indicate benthic life is seasonally stressed at all locations in Lake Barkley, except for the most upstream station. Using the North Carolina Biotic Index, all stations on Lake Barkley rated “fairly poor” or “poor”.

The ROS EIS rated mussels as poor in Kentucky Lake. The Corps of Engineers recently monitored mussels in both Kentucky and Barkley Lakes. Mussels in Kentucky Lake were stable between 1995 and 2000 monitoring; however, the mussel community in Lake Barkley showed a serious decline. This maybe related to the seasonal stress from low DO levels.

In the ROS EIS, fish populations in Kentucky Lake were rated as good or fair based on Reservoir Fisheries Assessment Index (RFAI). Lake Barkley had a similar assessment using fish in 1998-1999 and, based on the RFAI, it rated as good for the overall reservoir and as good or fair in three embayments. Two embayments (Eddy Creek and Little River) were selected for evaluation since they were suspected to be highly enriched.

Fish and benthic macroinvertrebrate populations appear stable in Kentucky Lake at current operations. Mussel populations in Kentucky Lake are expected to follow a long-term decline with some more common species showing steady populations but overall community diversity declining.

The tailwaters of Kentucky and Barkley Dams were rated as good for fish populations and fair for macroinvertebrates. Mussels show higher diversity than in the lake and each tailwater contains a mussel sanctuary, where commercial mussel harvest is prohibited.

Sport Fisheries. Both Kentucky and Barkley Lakes are heavily utilized by sport fishermen. Each lake has diverse habitats for a variety of sport fish. The ROS EIS provides a detailed discussion of sport fishing conditions and use. Kentucky Lake was rated as high for sauger. Crappie and black bass are also rated as high and appear more sensitive to year-to-year variations. Both species appear to do better in years with "more natural" flooding conditions in late winter/early spring. These flood events provide good spawning and juvenile fish habitat with high pools inundating areas of heavier brush and cover. It is expected that sports fishing on Lake Barkley would follow similar patterns.

4.4 Wetlands. The ROS EIS listed estimates of wetland areas in and along Kentucky Lake and Lake Barkley. Only wetlands that were thought to be in the zone of influence of the pool and groundwater influenced by the pool levels were considered. The types and acreage of potentially affected wetlands were estimated based on data selected from the National Wetlands Inventory (NWI). Kentucky Lake had the largest area of wetlands of all the TVA reservoirs and Lake Barkley had the fourth largest area (of reservoirs included in the ROS EIS). Shown below in Table 2 is the area estimated by wetland types as originally listed in Table 4.8-01 of the ROS EIS:

Table 2
Wetland Area by Wetland Type for Barkley and Kentucky Lakes only
(Source -Table 4.8-01 of ROS EIS)

Reservoir	Combined Aquatic Beds and Flats (acres)	Emergent (acres)	Ponds (acres)	Forested (acres)	Scrub/ Shrub (acres)	All Types (acres)
Kentucky	3,539	3,492	417	32,783	3,361	43,592
Barkley	1,246	1,376	248	5,431	2,433	10,733

The existing reservoir fluctuations and the relatively flat topography in and adjacent to the lakes aids development of large areas of flats, emergent, and scrub/shrub wetland types. The shallow areas of the lake which were, prior to impoundment, the river floodplain are now large flats that are considered wetland in the NWI.

The ROS EIS provided discussion of vegetation classes and water regimes. Vegetation classes most likely affected by the proposed pool change would be seasonally exposed flats, emergent wetland and scrub/shrub wetland that occur in the drawdown zone. These categories can overlap depending on year-to-year water level operations and available seed banks. For example, when aquatic beds are exposed, they function as flats; likewise, while flats are submersed, they sometimes develop aquatic bed vegetation. Scrub/shrub wetlands are found along the upper perimeter of the lakes in the highest portion of the drawdown zones and take longer to develop.

State and federal agencies have invested in infrastructure for controlling water levels to enhance and provide additional wetland functions in many areas associated with Kentucky Lake and Lake Barkley. These controlled wetlands include national wildlife refuges (NWRs), wildlife management areas (WMAs), and a waterfowl refuge. Table 4.8-02 of the ROS EIS lists wetlands with water level control structures on Kentucky Lake. In addition to those listed in the ROS EIS, Lake Barkley also has Cross Creek NWR which is part of the Tennessee National Wildlife Refuge Complex and other areas managed by state wildlife agencies for wetland vegetation and waterfowl use. Several impoundments within the Tennessee NWR complex lack pumping capabilities and are operated to drawdown as the lakes recede. Listed below in Table 3 are areas managed for wetland functions or for vegetation for waterfowl use. This includes information from the ROS EIS plus some additional wetlands on Lake Barkley.

Table 3
Areas Managed for Waterfowl and Wetland Functions
in Barkley and Kentucky Lakes

Wetland Name	Reservoir	Invested Agencies	Acres
Duck River Unit	Kentucky	USFWS-Tennessee NWR	4,688
Busselltown Dewatering Unit	Kentucky	USFWS-Tennessee NWR	204
Big Sandy Unit	Kentucky	USFWS - Tennessee NWR	50
Camden Dewatering Unit	Kentucky	TWRA-TVA	3,937
West Sandy Dewatering Unit	Kentucky	TWRA-TVA	3,730
Big Sandy Dewatering Unit	Kentucky	TWRA-TVA	1,738
Perryville Dewatering Unit	Kentucky	TVA	308
Gumdale Dewatering Unit	Kentucky	TVA	152
Cross Creek NWR	Barkley	USFWS	1,500
Duck Island/Barkley Islands WMA	Barkley	KDFWR	5,249
Bear Creek WMA	Barkley	USACE	690
Barkley (Dover Bottoms) WMA	Barkley	USACE	3,600
Energy Lake WMA - LBL	Barkley	USFS	5
Devils Elbow	Barkley	USFS	3

4.5 Terrestrial Ecology. In the TVA ROS EIS, the area within 0.25 miles of the reservoir shoreline was the study area for terrestrial ecology. Vegetative communities were grouped into two broad categories: lowland and upland. Lowland communities are most likely affected by changes in reservoir operations. Plant communities found in lowland areas include scrub/shrub wetland, bottomland hardwoods, and flats. Changes in elevation, duration, and timing of flooding of lowland communities may affect the distribution and species composition. As vegetation is changed, wildlife that utilizes a

particular vegetation community is also affected. The TVA ROS EIS stated that changes in reservoir operations policy could affect:

- Distribution and species composition of both upland and lowland communities;
- Diversity and abundance of associated wildlife communities;
- Shorebirds and waterfowl.

Wildlife dependent on flats, wetlands, or other lowland community types would potentially be affected by proposed pool changes. These groups of wildlife include migratory waterfowl, wading birds, shorebirds, songbirds, reptiles, amphibians, and small mammals.

Lowland Plant Communities. The TVA ROS EIS provides three tables (Tables 4-6 of this EA) of representative lowland plant species listed by bottomland hardwood forests, trees and shrubs found in scrub/shrub wetlands, and plants found on reservoir flats. As mentioned earlier, these plant communities can shift with varying water levels.

Table 4 (Original Source is Table 4.10-03 of ROS EIS)

Table 4.10-03 Representative Tree Species Found in Bottomland Hardwood Forests

Common Name	Scientific Name
Bald cypress	*Taxodium distichum*
Black gum	*Nyssa sylvatica*
Black willow	*Salix nigra*
Box elder	*Acer negundo*
Cottonwood	*Populus deltoides*
Green ash	*Fraxinus pennsylvanica*
Hackberry	*Celtis occidentalis*
Red maple	*Acer rubrum*
River birch	*Betula nigra*
Silver maple	*Acer saccharinum*
Sugarberry	*Celtis laevigata*
Sweet gum	*Liquidambar styraciflua*
Sycamore	*Platanus occidentalis*
Water oak	*Quercus nigra*
Water tupelo	*Nyssa aquatica*
White oak	*Quercus alba*
Willow oak	*Quercus phellos*

Tables 5 and 6
(Original Source is Table 4.10-04 and 4.10-05 of ROS EIS)

Table 4.10-04 Representative Tree and Shrub Species Found in Scrub/Shrub Wetlands

Common Name	Scientific Name
Black willow	*Salix nigra*
Box elder	*Acer negundo*
Buttonbush	*Cephalanthus occidentalis*
Green ash	*Fraxinus pennsylvanica*
Red maple	*Acer rubrum*
Silky dogwood	*Cornus amomum*
Silver maple	*Acer saccharinum*
Smooth alder	*Alnus serrulata*
Swamp loosestrife	*Decodon verticillatus*
Swamp rose	*Rosa palustris*
Sycamore	*Platanus occidentalis*
Virginia willow	*Itea virginica*
Water hemlock	*Cicuta maculata*

Table 4.10-05 Representative Plant Species Found on TVA Reservoir Flats

Common Name	Scientific Name
Amazon sprangletop	*Leptochloa panicoides*[1]
Blunt spike rush	*Eleocharis obtuse*
Bosc's mille graines	*Oldenlandia boscii*[1]
Clustered mille graines	*O. uniflora* [1]
Grassleaf mudplantain	*Heteranthera dubia*[1]
Grasslike fimbry	*Fimbristylis miliacea*[1,2]
Lowland rotala	*Rotala ramosior*
Slender fimbry	*Fimbrystylis fallalis*
Smallflower halfchaff sedge	*Hemicarpha micrantha*
Teal love grass	*Eragrostis hypnoides*
Vahl's fimbry	*F. vahlii*[1]
Valley redstem	*Ammania coccinea*
Variable flatsedge	*Cyperus difformis*[1,2]
White-edge flatsedge	*Cyperus albomarginatus*[1]
Yellowseed false pimpernel	*Lindernia dubia*

[1] In the Tennessee Valley, the distribution of this species is essentially restricted to the TVA reservoir flats.
[2] This species is not native to the Tennessee Valley.

Source: Webb et al. 1988.

There is particular concern for the scrub/shrub wetlands that form along the higher margins of the drawdown zone. The extent of scrub-shrub wetlands had decreased markedly over the past 20-30 years. Buttonbush is a dominant species in these wetlands and is sensitive to prolonged inundation of its roots. Its decrease is likely due to both the water level changes adopted in 1980 and an insect pest that reduces the viability of its seeds. Large areas of buttonbush still occur at the head of many embayments and along much of the shoreline. Scrub-shrub wetland habitat is vital to some sports fisheries such as crappie and largemouth bass as it provides ideal spawning and cover for juvenile fish.

There is also concern that plant species that occur in reservoir flats could be affected if the duration of the water levels is extended. Most of the species that occur in the flats now have adapted to being inundated for most of the growing season, then being able to quickly germinate and grow once water levels recede. Some plant species are also able to accommodate the occasional year of extended pools by producing seeds that can be viable for several years. In this manner they are able to miss an occasional high water year and still produce seeds during years that are more typical (*Seed Germination Ecology of Summer Annual Species of Dewatered Reservoir Shorelines (Mudflats), A Temporally Unpredictable Habitat* by Baskin, Baskin, and Chester, 2002).

The concern for plants on reservoir flats is that any extension of summer pools may eliminate or significantly reduce the coverage and diversity of plants on the flats. This change would primarily result from the reduction in the length of the growing season. Plants on flats provide both food and cover for shorebirds and waterfowl that utilize the lakes during fall migration and over winter.

Terrestrial Wildlife. Lake Barkley and Kentucky Lake provide a wide variety of habitat types. In conjunction with The Land Between The Lakes and other state and federal wildlife refuges, this north-south corridor is extremely important to migratory birds. Other year-round species of birds, mammals, reptiles, and amphibians also utilize the variety of plant communities and abundant water so that a diverse assemblage of wildlife can be found along the lakes.

The following excerpted text from the ROS EIS (section 4.10.5) discusses the importance of the lakes for migratory shorebirds and waterfowl:

"Shorebirds forage in moist drawdown zones along the reservoirs seasonally; concentrations are highest during fall migration. Flats, isolated pools and shallow water habitats are created by the current reservoir drawdown of Barkley and Kentucky Lakes. With the existing drawdown beginning on July 5th, shorebird habitat is usually available in early August. And this habitat coincides with the peak of the fall migration. Flats are important to shorebirds as they forage in these areas to build fuel reserves necessary to migrate to their wintering grounds. The slowly receding waters result in large open areas of shallow water and moist, exposed flats critical for foraging and resting. Kentucky Lake and Lake Barkley contains excellent examples of these habitats." Figure 4 shows Bear Creek Waterfowl Management Area north of Dover on Lake Barkley at low water. Large expanses of mudflats are visible in the photograph.

Figure 4
Photograph of Bear Creek Waterfowl Management Area (Lake Barkley)

During fall and winter, a mixture of water depths, wetlands, riparian vegetation, aquatic macrophytes, shallow flooded overbanks, and agricultural fields provide valuable habitat to large aggregations of waterfowl on the lakes. Vegetated flats provide foraging habitat for geese and ducks during winter. The existing summer drawdown allows the flats to be exposed for vegetation development before the end of the growing season, thereby benefiting waterfowl. The lakes are surrounded by a variety of state and federal wildlife refuges that actively support migrating waterfowl and shorebirds. Many of these areas operate dewatering projects, which provide resources that are important to migratory birds. During winter, large concentrations of gulls roost and forage on the flats, as do smaller numbers of a few species of shorebirds such as Wilson's snipe and killdeer. Overall, the use of the lakes by migratory birds varies throughout the years and largely depends on weather patterns, dynamics of bird populations and water levels.

Information provided by the U.S. Fish and Wildlife Service - Tennessee National Wildlife Refuge Complex is summarized in the remainder of this section with the complete letter shown as Item 4 in Appendix 1. Average peak fall migration of shorebirds in the Tennessee Valley is typically mid-August. Habitat area away from the lake area is limited due to normally dry conditions and dense vegetation that has grown

throughout the summer. For this reason, the fall drawdown in Kentucky and Lake Barkley is extremely important. Since most shorebird species prefer habitats that are open and away from dense cover, water levels need to be low enough to expose flats that are not covered by woody vegetation. These necessary water levels vary somewhat with distance from the dams. In the vicinity of the Big Sandy Unit, Tennessee National Wildlife Refuge, woody vegetation typically exists down to elevation 357.5 mean sea level (MSL). For adequate mudflat habitat to be available, the pool elevation needs to be around 356.6 MSL. Under the existing guide operations, this level is scheduled to be reached during late August. However, this is not the case during normal dry years because the "noise" around the guide curve is more often above the guide curve than below the curve. Therefore, during most years, adequate shorebird habitat is not available until mid-September. This illustrates that loss of shorebird habitat has occurred due to the pool level extension that was implemented in 1980.

Blue-winged teal are the first migrating waterfowl to arrive in Tennessee. The Tennessee Valley is one of two main migration corridors. They first arrive in early August with the peak migration around mid-September. Blue-winged teal utilize mudflats for feeding and resting and commonly feed on seeds of sedges, grasses, and smartweed that were deposited on the flats during previous years, as well as on insects and mollusks that may be present. The existing management of the lakes provides good habitat at the appropriate time of the year for blue-winged teal to stop during their migration.

Another early migrant bird that utilizes the mudflats is Canada geese from the Southern James Bay Population (SJBP). The SJBP geese winter within the Tennessee Valley and first arrive around September 20. The best habitats available in September are the flats associated with the lakes.

Wigeon are another waterfowl species that utilize mudflat habitats in the reservoirs. Wigeons fed on the leafy portions of annual plants that grow on flats. Population trends monitored at the Tennessee National Wildlife Refuge since 1964 show population declines for wigeons that started soon after the 1980 summer pool extension. The average annual peak population for wigeon prior to the summer of 1980 was over 33,000 as compared to 8,600 after the Kentucky Lake pool was extended.

4.6 Threatened and Endangered Species. Listed below are federally listed species that are known to occur in the project area. Most likely to be affected by summer pool extensions are the mussels (fat pocketbook, pink mucket, orangefoot pimpleback, and ring pink), least tern, piping plover, and bald eagle. The piping plover and least tern use the flats for resting during migration. Bald eagles are regularly observed in the reservoirs feeding on fish trapped in pools within the flats during drawdown. The piping plover (Great Lakes Population) is thought to number less than 60 breeding pairs. This population is listed as federally endangered in the breeding grounds and as federally threatened away from the breeding grounds. The Great Lakes populations are likely to migrate through the Tennessee Valley, where the species is rare.

A significant mussel resource exists below Barkley and Kentucky Dams. This resource includes several federally listed species, including the federally endangered pink mucket, *Lampsilis abrupta*, orangefoot pimpleback, *Plethobasus cooperianus*, ring pink, *Obovaria retusa*, fanshell, *Cyprogenia stegaria*, fat pocket book, *Potamilus capax*, and the candidate species the sheepnose, *Plethobasus cyphyus*. The existing flow regime and habitat below the two dams is important in maintaining these mussel resources.

List of Threatened and Endangered Species

Below Kentucky Dam

Ring pink (Obovaria retusa)
Fanshell (Cyprogenia stegaria)
Orangefoot pimpleback pearlymussel (Plethobasus cooperianus)
Pink mucket pearlymussel (Lampsilis abrupta) (=L.orbiculata)
Bald eagle (Haliaeetus leucocephalus)
Least tern (Sterna antillarum)
Piping plover (Charadrius melodus)

Below Barkley Dam

Indiana bat (Myotis sodalis)
Gray bat (Myotis grisescens)
Bald eagle (Haliaeetus leucocephalus)
Least tern (Sterna antillarum)
Piping plover (Charadrius melodus)
Fat pocketbook pearlymussel (Potamilus capax)

Above Kentucky Dam

Gray bat (Myotis grisescens)
Bald eagle (Haliaeetus leucocephalus)
Pink mucket pearlymussel (Lampsilis abrupta) (=L.orbiculata)
Price's potato bean (Apios priceana)
Piping plover (Charadrius melodus)

Above Barkley Dam

Indiana bat (Myotis sodalis)
Gray bat (Myotis grisescens)
Bald eagle (Haliaeetus leucocephalus)
Pink mucket pearlymussel (Lampsilis abrupta) (=L.orbiculata)

4.7 Managed Areas or Ecologically Significant Sites. Managed areas and ecologically significant sites are lands set aside for a particular management objective or lands that are known to contain a sensitive biological, cultural, or scenic resource. Many of these areas are located on or adjacent to Lake Barkley or Kentucky Lake and could be affected by changes in pool levels. For example, extending summer pool or raising the existing guide curve into the fall migration season could adversely affect wildlife refuges with flats critical to migratory birds. Several special managed areas were previously discussed in

the wetlands section. Table 3 lists areas that have water control management to provide wetland habitat values such as food or cover.

There are over 7,000 acres of managed waters within dozens of impoundments on the Tennessee and Cross Creeks NWR (administered as the Tennessee National Wildlife Complex). These impoundments are managed to provide a variety of wetland habitats, primarily for migratory and wintering waterfowl. When the lakes are at winter pool, the impoundments are lowered (in early spring) to allow development of food plants for waterfowl. Many of the impoundments are situated at a low elevation and do not have mechanical pumping capabilities, therefore, water must be removed (by gravity) when the lakes are at winter pool. Even in impoundments with pumping capabilities, impoundments are drained by gravity to reduce operational costs for the refuge. On impoundments without pumps, summer precipitation gradually refills the impoundment, limiting the area that is planted with agriculture (food crops) or moist soil vegetation.

On the Tennessee NWR, most impoundments are located in the Duck River Bottoms dewatering unit and these currently have pumping capabilities. The impoundments on the Busseltown and Big Sandy units of Tennessee NWR and all the impoundments on Cross Creeks NWR do not have established pumping capabilities. Portable pumps can be used on the smallest impoundments, but efficiency and available personnel limit their effective use.

The existing lake management (drawdown beginning on July 5), is borderline on being too late for effective moist soil or agricultural production in impoundments without pumping equipment in the NWRs.

Other managed areas are located within the LBL (USFS) or elsewhere on Lake Barkley and are within the drawdown zone of the lake. Lake Barkley has waterfowl or wildlife management areas that are administered by the Corps, Kentucky Department of Fish and Wildlife Resources, or the Tennessee Wildlife Resources Agency. These areas may be planted with food crops and are directly affected by lake levels. Other ecologically significant areas include the two mussel sanctuaries below the dams. The sanctuary below Kentucky Dam supports a diverse and abundant mussel assemblage.

Table 7 provides information for managed areas on the two lakes and tailwaters (source is Table 4.14-01 of ROS EIS). An estimated 32% of the shoreline of Kentucky Lake is comprised of managed areas or ecologically significant sites.

4.8 Shoreline Erosion. The ROS EIS discussed shoreline erosion in general but did not contain specific information on Kentucky Lake. The U.S. Fish and Wildlife Service, Tennessee National Wildlife Refuge complex, provided some specific concerns about the high rate of shoreline erosion on the two lakes and potential effects on riparian and upland habitats along the lakes. The Tennessee NWR and TVA are partnering on shoreline stabilization of several sites to protect upland habitats, archeological sites, and to stabilize islands. The Corps has partnered with the Cross Creeks NWR to stabilize shorelines along the refuge on Lake Barkley. The Corps also partnered with the KDFWR

to stabilize the Duck Island Waterfowl management area. Many private landowners adjacent to the lakes have stabilized their bank portion in order to avoid loss of both government property and adjacent private lands.

At the higher summer pool, waves generally hit a more vertical bank face. When lake elevations are below summer pool, this wave action is more effectively dissipated on more gradual surfaces such as flats, chert/gravel beds or more gently sloping clay banks.

Table 7 (Source ROS EIS Table 4.14-01)
Managed Areas or Ecologically Significant Sites Associated with Kentucky Lake and Lake Barkley

Reservoir	Managed Areas	Ecologically Significant Sites	Total Natural Areas	Pooled Reservoir Areas	Tailwater and Mainstem Riverine Habitats	Upland and Headwater Areas
Barkley	20	5	25	10	0	15
Barkley Tailwater	1	2	3	0	1	2
Kentucky	66	19	85	17	0	55
Kentucky Tailwater	4	1	5	0	13	2

4.9 Cultural Resources. Shoreline areas near large streams such as the Cumberland and Tennessee Rivers and their smaller tributary streams were heavily used both by prehistoric Native Americans and during the historic period from the seventeenth Century to the present. An archeological study was conducted for TVA in 1984 by Kenneth C. Carstens, Ph.D. (Carstens 1985) that included a 10% stratified random sample survey supplemented by a stratified systematic sample survey of designated portions of the shoreline of the lower 120.4 miles of Kentucky Lake. The abstract for the resulting report states: "The purpose of this study was to provide TVA with a probabilistic study of the cultural resources that occur, or which would by expected to occur, within the Lower Tennessee River Valley (generally speaking, from Kentucky Dam to Pope, Tennessee). Statistical studies incorporated "environmental zoning" into the research design so that an accurate prediction of sites (cultural resources) per physiographic zone could be accomplished….Field reconnaissance located 82 cultural resources (sites) within the selected statistical sample. Yet, the statistical tables suggest that additionally, more than 500 sites probably exist within the total study area. The findings reflect the greatest density of sites occur on islands, followed by large embayments and intermediate embayments. Most importantly, islands and embayments (due to water fluctuations and resort developments, respectively), are also the most endangered physiographic and cultural resource zones." A similar archeological study along 24 miles of shoreline within the Cross Creeks National Wildlife Refuge portion of Lake Barkley, but including a 100% sample of the shoreline, resulted in the identification of forty-three site locations,

of which more than half were considered significant and potentially eligible for listing on the National Register of Historic Places (DuVall 1996).

The Tennessee NWR complex is nationally known to have a wealth of archeological sites. Other historic sites located on shoreline areas include the Fort Donelson National Military Park (Lake Barkley) and Shiloh National Battlefield, Sycamore Landing, and Johnsonville Historic District, all on Kentucky Lake. The Shiloh battlefield has had bank stabilization projects to protect eroding banks.

4.10 Visual Resources. The discussion of visual resources in the ROS EIS and factors affecting visual resource issues associated with pool levels operations are:

- Exposed barren zone following reservoir drawdown;
- Exposure of reservoir bottoms and flats;
- Shoreline development/land use.

These two mainstem reservoirs are surrounded by flat terrain and reservoir operations generally have small impact on visual resources. However, pool drawdown on mainstem reservoirs does expose a large surface area (area exposed per foot of drawdown). In the ROS EIS, TVA used three scenic value criteria to describe and assess visual resources within the scope of pool levels operations. Criteria used were: scenic attractiveness, landscape visibility, and existing scenic integrity. Table 4.19-02 of the ROS EIS provided a description of the existing scenic conditions for Kentucky Lake, and Lake Barkley would mirror its conditions. The following visual resources information on the three scenic value criteria for Kentucky Lake is pulled from the ROS EIS:

Scenic Attractiveness:

- Moderate to high;
- Narrow southern half that is more characteristic of a river (large extent of undeveloped, natural-appearing vegetated shoreline);
- Wide expanse of water in northern half, with higher level of development present but large extent of natural-appearing shoreline remaining.

Landscape Visibility:

- Moderate to high;
- Low to moderate opportunity for viewing in southern half;
- Moderate to high opportunity for viewing in northern half;
- State parks, commercial recreational developments, Land Between The Lakes National Recreation Area in northern half.

Existing Scenic Integrity:

- Typical headwater drawdown is 5 feet;
- High water level is maintained from late April into early July;

- Flood conditions occasionally occur;
- Moderate shoreline development evident around northern half;
- Industry is present.

The three factors impacting visual resources that are most associated with pool level operations are the barren zone associated with reservoir drawdown, exposure of reservoir bottoms or flats, and shoreline development. With the existing drawdown, the barren zone is not highly noticeable due to the flat terrain. Shrub/scrub vegetation (black willow and buttonbush) in the higher portions of the drawdown zones also improves the scenic appearance. Exposure of reservoir bottoms is more of an issue in Kentucky Lake due to the large area exposed during drawdown. The visual effect at winter pool ranges from occurrence of sandbars and small islands to extensive flat areas that are dry with exposed ground. Many of these large, exposed flat areas are associated with wildlife management areas or other natural areas that exhibit wetland characteristics. Consequently, their appearance tends to blend in an acceptable degree with the surrounding landscape. In other cases, flats are a notable part of residential viewsheds, where the change in landscape character is not as acceptable and was interpreted as creating a lower level of scenic integrity. Shoreline development in the two lakes is moderate on the non-LBL side of the lakes in the northern half. The presence of LBL provides one shoreline of undeveloped landscapes in the northern lake reaches. The presence of several wildlife management areas, wildlife refuges, and undeveloped TVA lands also provides additional undeveloped shoreline.

4.11 Flood Control. Lake Barkley and Kentucky Lake are mainstem storage projects that are operated for flood control in addition to other project purposes such as navigation, water supply, recreation, water quality, hydropower, and fish and wildlife resources. Figure 2 shows the guide curve for the lakes and the top of the flood control pool is elevation 375'. For the majority of the time, the lakes are operated on or slightly above the guide curve. The ROS EIS provided a detailed description of the TVA water control system (Section 2.3) and flood control operations (Section 4.22). The latter focuses on flood control points within the Tennessee River system upstream of Kentucky Lake.

During periods of flooding on the lower Ohio and Mississippi Rivers, releases from Kentucky and Barkley Dams are coordinated with the Corps' Great Lakes and Ohio River Division to aid in reducing flooding on those rivers. The location of the two lakes in relation to the downstream rivers, makes these two projects the only major water resources projects that provide direct flood control capabilities.

Consistent with the Flood Control Act of 1944, the Corps may direct TVA flow releases from Kentucky Reservoir to reduce flood crests on the lower Ohio and Mississippi Rivers. A declaration of flood control operation is made at the discretion of the Corps when the stage at Cairo, Illinois gage reaches 35 feet and is predicted to go above 40 feet. The flood control operation ends when the stage at Cairo falls to 40 feet and further recession is predicted.

During the period from June 1 to November 30, a 1984 Memorandum of Understanding (MOU) between the Corps and TVA, limits the maximum storage to 365', ten feet less than the winter and spring maximum of 375'. Under the MOU, the Corps can issue directives to store water above 365' when the stage at Cairo is at or exceeds 55'. However, the Corps becomes liable for all administrative and litigation costs and any incurred damages.

For the purposes of this EA, the scope of flood control impacts includes the pools of Kentucky Lake and Lake Barkley and the downstream river reaches (lower Tennessee, Cumberland, and Ohio Rivers and Mississippi River). Another consideration related to flood control is the frequency and magnitude of spilling operations from the two dams due to potential development of supersaturated gas levels in the tailwaters and potential fish kills.

4.12 Navigation. Barkley and Kentucky Dams are the most downstream projects that maintain navigation pools on the Cumberland and Tennessee Rivers. The Corps maintains a 9 foot deep navigation channel on 381 miles of the Cumberland River (upstream to Celina, Tennessee). TVA maintains a 9 foot navigation depth with an 11 foot channel on 850 miles of navigable waters on the Tennessee River (upstream to Knoxville, Tennessee) and tributaries. Both recreational and commercial vessels utilize the navigation system. Commercial traffic primarily consists of coal, sand and gravel, agricultural products, petroleum and chemicals.

Navigation below the two dams continues down the lower Cumberland and Tennessee to the Ohio and Mississippi Rivers. There are no control structures downstream of Dam 53 on the Ohio River. Likewise, there are no control structures below St Louis (Chain of Rocks Lock and Dam) on the Mississippi River. Therefore, navigation depths depend entirely on flow volume in these reaches.

Existing operation policy at Kentucky Dam, as outlined in the ROS EIS, requires that TVA provide a maximum of 25,000 cfs at Kentucky Dam to maintain a 301 foot tailwater elevation for commercial navigation. In low flow periods, releases from Kentucky Dam and the Corps' use of wickets gates at Lock and Dam 53 (which have to be set by hand) provide the only controls for tailwater elevation at the heavily utilized Kentucky Lock and the Paducah port area.

During periods of extreme low-flow periods, when minimum river depths for commercial navigation are problematic on the lower Ohio and Mississippi Rivers, releases from Kentucky and Barkley Dams are coordinated with the Corps' Great Lakes and Ohio River Division to aid in improving navigation on those rivers. The interconnected Tennessee and Cumberland Rivers constitute only 6 percent of the total Mississippi River watershed above Memphis. During low-flow periods, however, discharges from the two dams contribute 25 to 40 percent of the total Mississippi River flow.

4.13 Hydropower Generation. Kentucky Dam generates hydropower for the TVA Power Service Area (shown as Figure 1.1-02 of the ROS EIS). Hydropower from

Barkley Dam serves both TVA and non-TVA power customers in the region. Hydropower plants are valuable due to the ability to rapidly start-up power generation to provide peaking power (power needed during periods (hours) of highest energy demand). There are also seasonal variations in energy demand and one high demand season is during the summer. Releases from the dams are scheduled to maximize their value to the power supply system by operating during peak demand hours of each day and typically more on weekdays than on weekends. The proposed extension of summer pool at Lake Barkley and Kentucky Lake would affect hydropower generation for the period of time that generation is delayed or rescheduled to extend summer pools. The shorter the duration of time for returning to the existing guide curve, the more aggressive the drawdown from summer pool would be. This might require generation during periods when power value is not maximized. Any shift of power generation from the middle of summer to later in the fall would also reduce the value of the power. However, the duration of extended pools being considered in this EA (to early or mid-August) would be during the summer high demand season. As discussed earlier, with the extended summer pools there is an increased risk of spillway releases, which would result in hydropower capacity lost.

4.14 Recreation. The existing lake drawdown beginning in early July does reduce the area of Lake Barkley and Kentucky Lake that can be easily navigated, especially by larger boats such as cruiser and houseboats. Many commercial marinas and shoreline property owners have commented that recreational uses are severely restricted once water levels drop below 357**'**. Large areas at the head of embayments are converted to flats. Access to several commercial facilities is limited at lower pool levels. Known problem spots include Buzzard Rock Marina where a shallow hump is often hit by houseboats. Two other commercial marinas (Kuttawa and Green Turtle Bay) have a narrow access channel with little room for error. The Eddyville Port Authority has a submerged road bed that restricts access to and from this facility. Numerous private docks have only seasonal access. The Corps maintains about 350 buoys along secondary channels of Lake Barkley in an attempt to alert boaters to hazardous areas. The south end of the lake has numerous shallow areas immediately adjacent to the marked navigation channel, much of this area is used as waterfowl or wildlife management areas. Two Corps of Engineers recreational areas (Dyer's Creek and Tobaccoport) become inaccessible from the main channel at winter pool. Boat ramps in these areas are usable, but only to reach the isolated pool.

The ROS EIS summarized results of a recreational survey at 35 projects in the Tennessee River system, including Kentucky Lake. This survey evaluated three groups of recreational users: general public (using public access sites); individuals using commercial facilities; and shoreline property owners with private access. Each group is affected by reservoir operations. Table 8 (original source is Table D8-01 of the ROS EIS, excerpted for selected mainstem projects on next page) shows recreation use estimates (user days) at mainstem projects during August, September, and October. A comparison of Kentucky and Guntersville Lakes shows that Kentucky Lake does have a greater decline in recreational use, especially in commercial use, during August and September. This decline can be attributed to the effect of the lake drawdown impacting

Table 8 (Source -Table 4.8-01 of ROS EIS)
Late-Summer Recreation Use for Selected TVA Mainstem Projects

Table D8-01 Recreation Use (User Days) at Mainstem Projects during August, September, and October

Project	Month	Total Recreation Use	Public Access Use			Commercial Use	Private Access Use
			Reservoir	Below Dam	Combined		
Chickamauga	August	141,738	14,590	4,876	19,466	51, 133	71, 139
	September	112,362	17,274	3,787	21,061	35,560	55,741
	October	64,102	9,789	1,895	11,684	21,801	30,618
Fort Loudoun	August	68,566	7,041	2,519	9,560	24,676	34,330
	September	54,499	8,336	2,103	10,439	17,161	26,900
	October	31,070	4,724	1,049	5,773	10,521	14,776
Guntersville	August	262,204	19,356	1,033	20,389	185,413	56,401
	September	249,289	20,144	1,986	22,130	179,276	47,883
	October	145,310	15,404	1,140	16,544	92,814	35,952
Kentucky	August	414,796	24,781	4,876	29,657	345,747	39,391
	September	279,687	33,552	3,787	37,340	210,914	31,433
	October	158,549	15,109	1,895	17,003	118,138	23,407
Nickajack	August	33,651	3,327	2,443	5,770	11,659	16,221
	September	26,797	3,939	2,040	5,979	8,108	12,710
	October	15,202	2,232	1,018	3,250	4,971	6,981
Pickwick	August	89,697	19,506	3,708	23,214	26,114	40,370
	September	81,279	20,966	3,123	24,090	25,625	31,565
	October	56,902	13,683	2,053	15,736	18,245	22,920

boating quality and access to some facilities. Guntersville Lake has a smaller (< 2 ft) drawdown and shows a less dramatic decline in use.

The affect of lower lake levels likely deters tourists from using the lakes, particularly those tourists that are less familiar with the shallow areas of the lakes. As such, particular recreational providers, including commercial marinas that rent houseboats, are more affected than other users. Users of public facilities are likely less affected since they may be more familiar with the lakes. Shoreline property owners may also have their private access (docks) restricted or eliminated depending on water depths to their property. Other recreational users not covered in the ROS EIS survey include non-summer users such as fishermen, hunters, or wildlife viewers. These may benefit from the existing lake operation since their use depends on the presence of a natural resource such as a sports fishery or waterfowl. The existing operation supports a year-round use for these types of users. Tailwater users are less dependent on pool operations with the exception of increased risk of spillway releases which can lead to gas supersaturation (fishing impacts) and potential for higher releases during any aggressive drawdown period which might create flows in excess of those desirable for tailwater fishing.

4.15 Social and Economic Resources. The ROS EIS discussed five pathways where changes in reservoir operation policy could result in direct economic effects: navigation, power, water supply, recreation, and property values. The extension of summer pool until July 15 on Kentucky Lake and Lake Barkley would result in little change in water supply and minor changes in navigation in the two lakes. Navigation impacts could be substantial downstream of the two dams. Power (hydropower) was discussed earlier. The other two pathways (recreation and property values) would be affected to a greater degree.

Recreation resources would have some positive and negative effects. Recreational uses more associated with the height of summer would benefit from an extension of summer pool. Commercial marinas state their boat rental business drops off significantly during the lake drawdown. Other factors such as the start of school year and the peak angling seasons for various sport fish could also affect visitation. This affects a number of related economic factors associated with summer tourism including lodging, food and restaurant sales, and gas sales. Other recreational users that utilize the lakes outside of the peak summer tourism season may be detrimentally affected if the impact of pool extensions degrades the resources that attract them to the lakes in the first place. For example, if fisheries or waterfowl are impacted by pool extensions, then over time a reduction in fishing and hunting use would occur. Businesses associated with these recreational uses include fishing and hunting guide services, lodging, gas and bait sales.

Another economic pathway directly affected by pool extensions would be property values. The ROS EIS listed a median structure value on Kentucky Lakes at nearly $72,000. In general, lake front property values would increase as the duration of time that summer pool is maintained increases. Notable exceptions to this statement would be properties with flowage easements on Kentucky Lake (34% of the shoreline). Increased risk of flooding counters the benefits to properties with flowage easements. Property within the viewshed of the lake (outside of flowage easements) would have some increased value with higher water levels. This increase diminishes with distance from the lake. Local governments would benefit from increased property tax revenues for the properties along the two lakes.

The increased risk of flooding downstream of the lakes could negatively affect property values and agricultural production along the lower Tennessee, Cumberland, and Ohio Rivers, and Mississippi Rivers. There would also be a slight increase in the risk of in-lake flooding with any pool extension; whether that would degrade property values is unknown.

Environmental Justice. Generally, federal agencies are required to determine impacts of federal actions on minorities or disadvantaged populations. Impacts of federal actions shall avoid disproportional impacts on these populations. For this EA, only U.S. Census Bureau data (2000) for the four Kentucky (Lyon, Trigg, Calloway, and Marshall) and two Tennessee (Henry and Stewart) counties most likely affected by pool extensions were examined. All six counties have a lower population of minorities than the national average. Two (Lyon and Calloway) of the four Kentucky counties and both Tennessee counties have a higher than the national average of families below poverty level. This evaluation should be expanded to include all affected project areas, including those downstream of the two lakes. These areas are likely to have populations that are at or near poverty levels. Additional studies are needed to define the affected area.

Section 5 Environmental Consequences.

5.1 Introduction. The environmental consequences section presented in this EA describes potential impacts of the proposed extension of summer pool from July 5 to July 15, followed by return (recovery drawdown) period until the lake elevation returns to the existing guide curve (refer to figure 1). It is assumed that pools would be lowered by generating hydropower at some accelerated rate to normally return to the guide curve during August 1-15. The resources discussed are in the same order as Section 4, Affected Environment. While effects are discussed by individual resource category, many of these impacts have compounding effects on multiple resource categories.

5.2 Water Quality. The environmental consequences with respect to water quality of the proposed extension of summer pool would be an increase in residence time of the lakes at the most critical time for most water quality processes. Increases in residence time would allow stronger thermal stratification to develop in the downstream portion of the lakes. The lacustrine (lake-like) zones of the lake would be extended up the main channel. Dissolved oxygen (DO) levels would be lowered below the epilimnion (surface layer) of the lake. Releases of anoxic products would increase as the area affected by very low DO levels (< 1 mg/l) increases. Algal growth would increase with the longer residence times.

Whether these changes would be of the magnitude to create water quality issues needs to be evaluated by water quality modeling of the lakes. For example, releases from Lake Barkley generally meet water quality standards, benefiting from a typical inflow of surface water from Kentucky Lake through the Barkley Canal and with the existing degree of thermal stratification. The effects of extending residence time of the lakes would drive water quality processes in the negative direction and resulting in lower DO in releases from Barkley Dam. In the tailwater, numerous DO readings are near or occasionally below the water quality standard of 5 mg/l. The increase in residence time would aggravate this situation by increasing the occurrences of the below standard readings.

Water quality of embayments is much degraded in comparison to the main channel since they are already affected by longer residence times and relatively higher nutrient loadings. The proposed extension would worsen water quality processes in the embayments but since they are already highly stressed, the effects would not be as noticeable. This is especially true for the non-LBL embayments of both lakes which have higher watershed nutrient loadings than embayments on the LBL side.

Effects on tailwaters of the two dams would be generally negative due to lower DO levels (due to higher residence times). The potential for spilling events and corresponding gas supersaturation would increase under the extended summer pool operation and resulting reduction of late summer flood storage capacity.

The ROS EIS evaluated various alternatives that were of longer duration than the current proposal. Water quality modeling of those alternatives generally concluded that any

alternative that extended residence time through mainstem projects would worsen water quality conditions. The Corps believes this would be the case for the proposed extension of summer pools in Lake Barkley, which appears to be more sensitive to water quality effects than Kentucky Lake. The proposed changes may push DO depletion and thermal stratification effects beyond acceptable limits. Additional detailed water quality modeling is needed to provide a more definitive determination.

5.3 Aquatic Resources. The proposed extension of summer pool on Lake Barkley is likely to have detrimental effects on fish species that rely on woody vegetation in the higher portions of the drawdown zone. The additional inundation of woody species (buttonbush and black willow) which occur in the scrub/shrub portion of the shoreline would result in a decrease in coverage for these species. These plant species currently occupy a zone generally from elevation 357.5 to 359 feet and this zone is important as spawning and cover for juvenile fish. Crappie and largemouth bass are popular sports fish that utilize this habitat zone. The extended duration of summer pool would compress the elevation range of these woody species. Over time this would likely negatively affect sport fisheries for crappie and largemouth bass. A detailed study performed by TVA-LBL in 1979 looked at buttonbush growth in six LBL embayments in the two lakes (three in each lake). This study found buttonbush did not occur below elevation 356' and was sparse below 357'. Since the pool change of 1980, scrub/shrub vegetation does not occur below elevation 357.5' in the lower portions of Kentucky Lake. This is a loss of spawning and cover for crappie and largemouth bass.

The effects on benthic macroinvertebrates would be mixed in that higher pool levels would create more shallow water areas for establishment of benthic life, but the lower DO levels below the epilimnion would eliminate some areas that currently support limited benthic macroinvertebrates.

Mussel monitoring in Lake Barkley between 1995 and 2000 have shown declines and extending the summer pool and the corresponding lower DO levels in the main channel would further stress mussels. The ROS EIS rated mussels as poor in Kentucky Lake, although the monitoring performed by Corps contractors (1995 and 2000) showed stable populations at the sampling sites. Detailed water quality modeling would be needed to definitively determine the magnitude of this change on mussels.

Effects on aquatic resources in the two tailwaters would also be detrimental due to an anticipated slight lowering of DO levels in the releases from the dam. As DO levels are lowered, growth and reproduction of fish would be negatively affected. On occasion, DO readings below Barkley Dam are below Kentucky water quality standards. The increased risk of spilling would increase the chance of fish kills due to super-saturated gas levels. This would depend on whether existing operational controls such as sequencing of gates used for spilling could keep gas levels from becoming problematic.

5.4 Wetlands. The proposed extension of summer pool would affect wetlands within the lakes by shifting and compressing the elevation zones where some wetland types currently occur. Most affected types would be scrub/shrub, emergent, and flats. The

scrub/shrub wetlands consist of small woody plants, commonly buttonbush, and their elevation range would be compressed with the lowermost plants getting flooded out. Emergent wetlands would be affected by reducing the growing season for herbaceous vegetation. Some species would be eliminated over time as the existing seed bank is exhausted and, with a reduced growing season, no germination or growth to maturity needed to replenish the seed bank. Likewise, flats would become more open and would decrease in area during the period the pool is above the present guide curve. The uppermost margins of wetlands may see some slight shift upward due to higher summer pools but not to the degree the lower margins would be impacted. Overall, the proposed pool extension would have a net negative impact on wetland area and habitat values.

In addition to the in-lake (unmanaged) wetlands, managed wetlands also occur in National Wildlife Refuges (NWRs) and wildlife management areas (WMAs). Managed wetland units that lack pumping capabilities would be negatively impacted by the proposed pool level change. Many of these units are drained by gravity and higher water levels would reduce the growing season for food and cover plants within these wetland cells. These units have already been impacted by the pool changes implemented in 1980 and the existing drawdown allows only marginally successful plant production in many wetland unit cells. Substantial capital investment would be needed to install and operate pumping equipment and provide manpower to meet habitat management objectives. Operating costs of wetland units with pumping capabilities would also increase.

5.5 Terrestrial Ecology. The proposed extension of summer pool on the lakes would result in impacts to existing occurrences of lowland plant communities, in particular scrub/shrub wetlands and flats. As discussed earlier, impacts to scrub/shrub wetlands would lead to a loss of woody species such as buttonbush and black willow which currently cover extensive areas at the head of embayments and along the shoreline. The elevation band of scrub/shrub wetlands (357.5’ to 359’) would be compressed.

Both emergent and open flats would also be affected by a reduced growing season for annual plants at a time when they provide important food and cover for both migratory and year round resident birds. Certain herbaceous species would likely be eliminated if they are unable to produce seeds in the reduced growing season. This would result in an upward shifting of the elevation bands for flats and emergent wetland annuals. The area of exposed open flats and vegetated emergent beds would be reduced with higher lake levels. Bottomland hardwoods and upland habitat would be impacted to a lesser degree, except where shoreline erosion is accelerated.

Terrestrial wildlife would be impacted from the reduction and shifting of lowland plant communities. Birds that utilize the scrub/shrub zones include red-winged blackbirds, prothonotary warblers and wood ducks. Year round resident wading birds such as great blue herons and songbirds would be affected by the reduced area of mudflats with extended summer pools. Several migratory bird species that use open flats and emergent beds for resting and feeding include waterfowl such as blue-winged teal, green-winged teal, Canada geese (Southern James Bay and other populations), and wigeons. These species are particularly susceptible to the presence of a viable (seed producing)

population of herbaceous wetland plants (annuals) since they feed on seeds deposited from previous years. Population monitoring of wigeons at the Tennessee NWR showed a decline attributed to the pool change that occurred in 1980. Flats are also important for many other year round resident and migratory birds such as bald eagle, gulls, terns, killdeers, plovers, yellowlegs, sandpipers, dowitchers and other wading birds.

Migratory shorebird species that feed in the moist drawdown zones are at their highest numbers during the late summer/fall migration. Under current pool operations during normal years, shorebird habitat (elevation 356.6') is reached about August 25. These species utilize the narrow strip of moist flats that follows the receding pool. Shorebird habitat degrades in quality as the flats dry. Birds using this zone include federally listed species such as the least tern and piping plover. TVA and the Corps are currently evaluating the availability of mudflat habitat under existing pool operations to provide an estimate of baseline habitat provided for migratory shorebirds. TVA committed to developing baseline data on shorebird habitat in Kentucky Lake as a result of the ROS EIS.

Compounding the impacts on terrestrial ecology directly within the lakes would be a corresponding loss of habitat in the two NWR under existing conditions. Areas without pumping capabilities would not provide the habitat value as provided under the existing drawdown. The existing drawdown allows these refuge areas to develop food and cover vital for large aggregations of waterfowl during the late fall and winter. With higher summer pools, the risk of flooding in NWR areas would increase.

Overall, the extension of summer pool would have detrimental impacts on some lowland plant communities and habitat for migratory and wintering bird species that utilize these areas during fall migration. With the exception of information collected for some waterfowl species at the Tennessee NWR, detailed estimates on baseline habitat conditions is lacking. A variety of indications do confirm that extended summer pools would stress some plant communities, possibly substantially reducing their availability for migratory birds. On-going efforts are underway to develop more detailed information on habitat (such as mudflats) available under existing operation in order to aid decision-making on pool operations. This effort is anticipated to take 3-5 years to establish a definitive baseline for shorebird habitat.

5.6 Threatened and Endangered Species. The proposed summer pool extension is likely to adversely affect three bird and four mussel species listed under the Endangered Species Act. The endangered least tern and the threatened piping plover would be affected by the reduced availability of open flats during critical late summer migration periods. The threatened Bald eagle winters in the lakes regions and typically feeds on the open flats. More detailed evaluations are needed to determine existing seasonal availability of mudflat habitat (baseline habitat) vital to the birds. Habitat modeling is needed to provide better evaluations of impacts on mudflats under various pools changes.

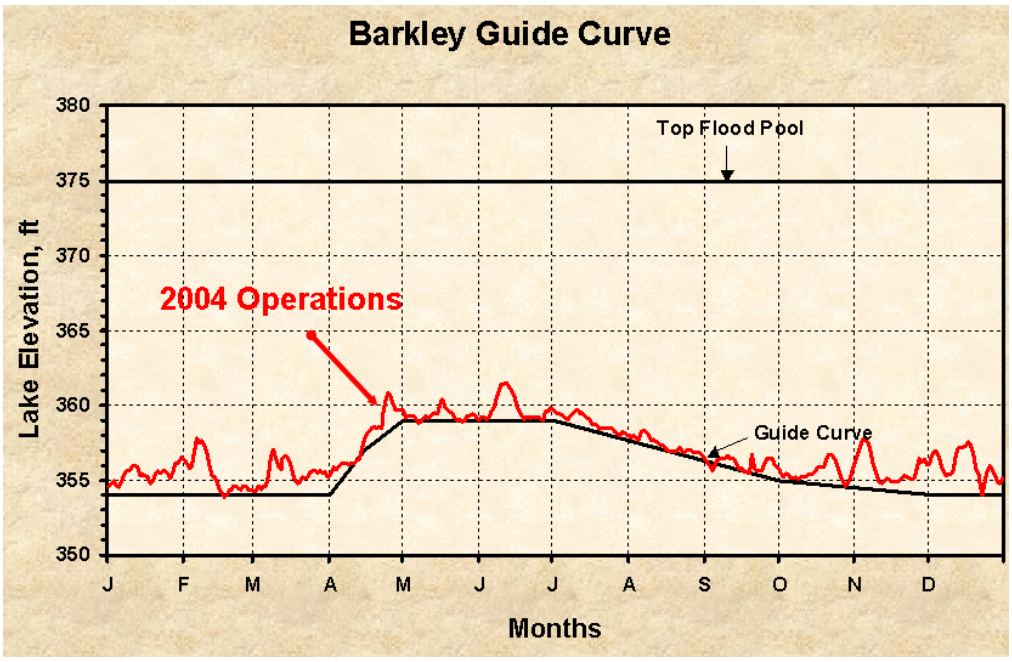
The tailwaters below Kentucky and Barkley Dams contain significant mussel resources, including several federally listed species (refer to Section 4.6). Changes in water quality

due to increased residence times would provide additional stress on mussel populations through lowered DO and increased temperature in the releases, as well as modifications in the existing flow regime. The magnitude of these changes needs to be better defined through water quality modeling.

Because of the potential adverse impacts to several listed bird and mussel species, summer pool extensions on the lakes would require initiation of formal consultation pursuant to Section 7 of the Endangered Species Act between the Corps of Engineers, TVA, and the U.S. Fish and Wildlife Service (refer to Appendix 1, Item 6).

5.7 Managed Areas or Ecologically Significant Sites. The proposed extension of summer pool would have detrimental effects on several managed areas that are intended to provide waterfowl habitat. Section 4.7 discusses managed areas located on Lake Barkley and Kentucky Lake. Impoundments on the Busseltown and Big Sandy units of the Tennessee NWR and all the impoundments on Cross Creeks NWR lack pumping capabilities. Water levels are reduced by gravity flow as the lakes are dropped after July 5th. For units that are managed for moist soil vegetation or agriculture production, the existing drawdown is currently borderline (i.e., almost too late). During wet years such as 2004 (shown in Figure 5), reservoir levels stayed higher than the guide curve throughout the summer and annual vegetation struggled to germinate. This reduced food (seed) available for wintering waterfowl and other birds. The proposed summer pool extension would make these types of conditions the norm. The extension of summer pool would essentially eliminate the management of hundreds of acres of seasonally flooded wetlands on Cross Creeks and Tennessee NWRs. Extensive capital investment would be required to provide pumping capabilities and manpower to meet the current habitat objectives for these refuges.

Figure 5 (Wet Year Conditions – 2004)



Other waterfowl management areas managed by the Corps, USFS-LBL, KDFWR, or TWRA would also be affected by extension of summer pool. These areas are directly linked to reservoir levels and rely on natural growth of annual wetland plant species to produce food and cover. These are primarily areas within the drawdown zones of the lakes.

Higher water levels would provide positive benefits with respect to recreational access to sites within LBL. Lake front campsites and boat ramps would be accessible longer into the summer. This in turn would promote visitation to LBL and regional tourism.

The two mussel sanctuaries below Kentucky and Barkley Dams may be adversely affected to some degree by water quality changes from increased residence times in the lake. Releases from the dams would have higher temperatures and lower DO levels, although additional modeling is needed to better define the magnitude of these changes.

Overall, the proposed extension of summer pool could have significant effects on managed areas that are dependent on the existing lake drawdown for development of annual wetland vegetation. These areas are only marginally successful under existing operations and year-to-year variations in summer pool. Extending summer pool would eliminate much habitat within these areas by reducing the growing season and seed production of annual plants.

5.8 Shoreline Erosion. The proposed extension of summer pool would increase shoreline erosion by exposing a more vulnerable portion of the bank face to longer durations of wind and wave action. In general, when water levels are at lower pool levels, this wave action is dissipated over a more gradual slope. Particularly at risk for damage are shorelines with archeological sites or NWR and WMA facilities such as roads, dikes, and water control structures. To prevent damage related to pool extensions, additional funding may be needed to provide bank protection to prevent the loss of such sites. Additionally, riparian habitat along the bank could be eroded. Erosion of private lands would increase where banks are not stabilized and government-owned lands are narrow.

5.9 Cultural Resources. Section 106 of the National Historic Preservation Act of 1966 requires Federal agencies to take into account the effects of their undertakings on historic properties. Historic properties are cultural resources, including districts, sites, buildings, or objects, that are determined eligible for or listed on the National Register of Historic Places. Regulations implementing this process, defined at 36 CFR Part 800, require delineation of an undertaking's "area of potential effects", identification and evaluation of potentially affected resources, assessment of adverse affect, and resolution of adverse affects through consultation with the State Historic Preservation Officer and other consulting parties, as appropriate.

As mentioned in the preceding section, extending summer pool levels could impact cultural resource sites that are adjacent to the river by increasing shoreline erosion. Shoreline areas near large streams such as the Cumberland and Tennessee Rivers and

their smaller tributary streams were heavily used both by prehistoric Native Americans and during the historic period from the seventeenth Century to the present. With the completion of construction of Kentucky and Barkley Dams many of these occupation locations (now archeological sites) are located, and often exposed, on islands and along the edges of tributary embayments within the respective reservoirs. The Tennessee NWR complex is nationally known to have a wealth of archeological sites; however, archeological sites occur consistently along the shoreline areas of both reservoirs. Additionally, looting of prehistoric graves and collection of artifacts along shorelines has been a consistent problem throughout the region. Higher water levels would also improve access to some sites for looters. Substantial capital investments could be needed to identify and address impacts to sites that are eligible for or listed on the National Register of Historic Places.

5.10 Visual Resources. The extension of summer pool would have both positive and negative affects on visual resources. The area of reservoir bottoms exposed would be reduced with higher water levels, although the current proposal would be of relatively short duration. Exposed reservoir bottoms are more visible from the developed areas of the northern portions of the lakes. The extension would produce a less natural appearance by reducing seed production of many annual wetland plants, resulting in less vegetation and more exposed soil on flats from fall through spring. Losses of scrub/shrub wetlands would also degrade the natural appearance of shoreline areas. Shoreline development would likely increase slightly with the higher pool levels making some properties more marketable. Again, the short duration of the current proposed pool change may minimize this affect. Overall for the current proposal, the positives are of short duration while the negatives are of longer duration.

5.11 Flood Control. The proposed extension of summer pool could impact flood control capabilities in and below the two lakes. The storage capacity lost during the period when lake levels are above the existing guide curve can be instrumental in preventing damages well downstream of the two dams because these are the only major water resources projects that provide direct flood control capabilities for the lower Ohio and Mississippi rivers. Although the difference in flood control storage would be small detailed hydrologic modeling is needed to better evaluate potential flood control impacts. The Corps' Mississippi Valley Division would be involved in this modeling since potential damage centers are well downstream on the Mississippi River. The argument that the proposed summer pool extension comes during the drier time of the year doesn't account for tropical storm systems such as those which have occurred in late summer and fall over recent years. The longer the duration of time pools are above the existing guide curve, the higher the flood damage potential. Extending the summer pool may increase the likelihood of exceeding elevation 365 in Lake Barkley and Kentucky Lake, resulting in higher flood damages that are incurred by the Corps. Preliminary estimate of the cost of hydrologic modeling studies are on the order of two million dollars. This type of evaluation is beyond the scope of the current EA.

5.12 Navigation. Lowering discharges from Kentucky and Barkley Dams during critical low flow periods could result in decreased depths, therefore, increased navigation

problems downstream of the Lock and Dam 53 on the Ohio River. This impact would continue downstream of Cairo, Illinois on the Mississippi River. This could result in interruptions of use of the river for shipment of agricultural and other products. Discharges from Kentucky Dam cannot be reduced below 25,000 cfs (ROS EIS commitment). Impacts to navigation could affect billion of dollars of interstate commerce, shipper savings, and water compelled rail rates. Detailed evaluation of navigation impacts from pool changes should be performed in any future EIS.

5.13 Hydropower. The proposed extension of summer pool would produce a slight reduction in hydropower generation by reducing the flexibility of power generation during the middle of summer. An aggressive drawdown from summer pool to the existing guide curve would also reduce operational flexibility for maximizing the value of hydropower generation. By delaying releases, water may not be available during times of maximum power value. Because of the short duration of the proposed pool extension, this may not be a major factor since the releases would still be during the seasonal peak summer demand period. Any increase in spilling frequency due to extended pool levels would also be power revenues lost from the TVA system. The proposed extension would increase the risk of spilling to some degree. Additional evaluation is needed to better define hydropower impacts.

5.14 Recreation. The proposed extension of summer pool would increase late summer recreational benefits and associated economic businesses for the lakes. The extension would come during peak boating visitation season. The recreation evaluation in the ROS EIS showed a decline in late summer recreational usage in Kentucky Lake, greater than the decline noted in other mainstem TVA projects that have smaller drawdowns. LBL commented that higher water levels could lead to increased visitation in their lake front facilities. Two marinas commented that their visitation drops off dramatically after summer pool is reduced and lake navigation is more limited. One commenter stated that many individual homeowners vacate their premises due to the lack of lake access at lower pool levels. These types of mid-summer recreational visitors would benefit from the proposed extension, although the short duration of the current proposal would minimize the benefits.

Other recreational users that rely on a productive fishery or bird/waterfowl populations would likely see a decline in usage as habitat is degraded to the point where the resource of interest is degraded. Fishing and hunting guide services would also be negatively affected over time as the resource is degraded.

Overall, a detailed evaluation is needed to better define net recreational effects of the proposed pool level change. Based on comments received from proponents of pool extensions, the short-duration of the proposed change would not produce their desired recreational effects. Some of the responses to the public notice illustrate this point (see items 16, 19-21 of Appendix 2. Many proponents of higher pool levels have recommended higher water levels well into the fall.

5.15. Social and Economic Resources. As discussed earlier, the two social and economic pathways most affected by changes in pool levels would be recreation and property values. Lakefront and lake view property is an important commodity for the regional economy, particularly in the northern reaches of the lakes. Potential benefits to mid-summer recreation and changes in property values need to be compared to impacts of pool extension with regard to year-round recreational users (fishermen, hunters, birdwatchers, guide services), increases in flood damages, lost power production, and mitigation costs for any impacts directly caused by pool extensions. This type of evaluation is beyond the scope of the current EA. Only through a detailed evaluation can an informed decision be made on overall social and economic affects. The proposed short duration pool extension is likely to cause slight beneficial effects for mid-summer users, but these would be countered by negative affects on a year-round basis. Based on comments received from proponents of pool extensions, the short-duration of the proposed change would not produce their desired social and economic effects.

Section 6 - Cumulative Effects Analysis

6.1 Introduction. The President's Council on Environmental Quality regulations as well as Corps of Engineers regulations for implementing the NEPA require a Cumulative effects analysis (CEA) be performed. Cumulative impacts are the effects of the proposed action when considered together with other past, present, and reasonably foreseeable future actions. Section 4 presented information on past and present environmental conditions for resource categories most likely affected by the proposed extension of summer pool.

The geographic scope of the CEA would be both Barkley and Kentucky lakes and downstream river reaches, including the lower Ohio and Mississippi Rivers. Although not considered in this EA, an argument could be made that the geographic area could be broadened to include the area for which the lakes draw visitors and the migration route for birds. The time frame used in the ROS EIS was thirty years into the future; similarly, the time frame for this EA is 30 years into the future (i.e., through 2036). Baseline is considered to be conditions of 1975, which reflects conditions after impoundment of Lake Barkley and initial stabilization of local resources to impoundment, but prior to the pool extension of 1980.

Proposed future projects and outside stresses that affect common resources are also to be considered. Consideration of all these factors leads to an analysis with a great deal of uncertainty, although the following discussion examines actions that are reasonable foreseeable to occur. This section provides a brief attempt at CEA for the resources discussed in sections 4 and 5. It is recognized that a more thorough CEA would be performed during any future EIS on pool extensions. Future trends for each resource category are evaluated under the extended summer pool alternative (hold summer pool until July 15, then return to guide curve between August 1 and 15).

6.2. Water quality. Water quality is generally acceptable, although poorer conditions occur in embayments and periodically in the mainstem during dry periods. Occasionally, tailwater DO levels are below water quality standards. Thermal stratification can develop but often is interrupted by high flow events. The proposal to extend summer pool would lead to additional declines in water quality by increasing residence time of the lakes, leading to stronger thermal stratification and associated water quality processes such as lower DO in bottom layers, higher surface temperatures, increased algal growth, in-lake anoxic products, and more frequent spilling from the dams (gas supersaturation). All but the latter are associated with residence time increases. Other cumulative stressors that affect water quality include increased organic and nutrient loadings due to population increases and land use changes in the watershed and thermal loads from cooling water discharges of coal-fired power plants. Another stressor would be climate trends that increase water temperatures and worsen thermal stratification. The latter in conjunction with pool extensions and increased nutrient loading could trigger more frequent and longer duration violations of water quality standards for DO below Barkley and Kentucky Dams, primarily as a result of changing thermal stratification.

6.3 Aquatic Resources. The extended summer pool and the other cumulative stressors discussed for water quality would have major effects on aquatic resources that are driven by water quality or availability of certain habitat types. Lower DO in bottom layers would adversely impact mussels and benthic macroinvertebrates in portions of the lake. Fish growth may be reduced by lower DO although they are mobile enough to move up in the water column. The loss of scrub/shrub wetland plants, particularly buttonbush and black willow, would degrade fisheries that rely on this habitat zone for spawning and nursery cover. Fish that would be affected include popular game fish such as crappie and largemouth bass. This effect was noted following past pool level changes made in 1980. In addition, fish kills already documented during periods of spilling from Kentucky Dam, would increase. The cumulative effect of proposed pool extension would likely be further incremental declines in quality of benthic, mussel, and fisheries resources of the lakes and tailwaters.

6.4 Wetlands. The ROS EIS states that wetlands are experiencing a minor but continuous decline. Past (1980) pool changes on the two lakes has been attributed to additional losses of scrub/shrub wetlands by compressing the elevation zone suitable for these plants. The past pool changes also led to a reduced growing season for annual wetland plants that occupy the emergent wetland zone. Wetland plants in portions of the two NWRs have also been degraded by this reduced growing season. Year-to-year variation in river flows magnifies the wetland impacts since there are years when high water levels do not permit seed production of annual plants in many low lying areas. Other cumulative stressors that affect wetlands include occurrences of insect pests and diseases of wetland plants and competition by invasive exotic vegetation, particularly submersed aquatic species. The incremental effect of extending summer pool would be compression of suitable wetland habitats and reduction of wetland functions.

6.5 Terrestrial Ecology. The extended summer pool would degrade future amounts of certain habitat types as well as negatively impact wildlife species that utilize these particular habitat types. The following is from the ROS EIS:

"Cumulative effects are possible, at least in the short term, on shorebirds and migratory waterfowl and the plant communities of flats habitats—in addition to the potential loss of control of gravity-maintained dewatering units on wildlife refuges on affected reservoirs. Impacts would be of greatest concern if they occurred during critical migratory periods. Cumulative effects may result from adverse impacts on managed areas and wetland habitats both important habitats for these bird populations." (from Section 6.2.6)

Other cumulative stressors that affect migratory birds include loss of habitat elsewhere in the migration route and hazards encountered during migration such as collision with buildings or towers. Other permanent wildlife species would be less affected as long as habitat exists elsewhere (private lands or LBL). The incremental impact of pool extension would be additional loss of habitats important to shorebirds and migratory waterfowl on the two lakes, with possible far-reaching impacts to bird populations throughout their range.

6.6 Threatened and Endangered Species. Three listed bird species and four mussels would experience additional stresses due to the summer pool extension. Two migratory shorebirds that utilize the mudflats currently available in the late summer and fall would be adversely affected by reductions in mudflat habitat, as well as by degradation of habitat elsewhere in the migration route. The loss of flood storage capacity could also reduce the availability of nesting habitat for interior least terns on Mississippi River sandbars downstream of Cairo. Changes in water quality associated with climate trends could lead to higher temperatures and stronger thermal stratification, and subsequently, lower DO in releases from the two dams. This would provide cumulative stresses on mussel resources (both the four listed species and other non-listed species) in the tailwaters. The USFWS has expressed concerns over cumulative effects due to past pool extensions, plus the incremental impact of the current proposal, and stated that formal consultation under the Endangered Species Act would be required before pool extension could be implemented.

6.7 Managed Areas or Ecologically Significant Sites. The past pool change (1980) produced documented effects on portions of the two NWRs which lack pumping capabilities for dewatering. Habitat objectives for the NWRs were impacted by the shorter growing season and the increased frequency of inundation during wet years. The proposal to extend summer pools would worsen this effect even more. The two tailwater mussel sanctuaries would also be impacted by additional degradation of water quality due to increased residence times. Other cumulative stressors associated with water quality, wetlands, flood control, and terrestrial ecology would have a combined adverse impact on managed areas or ecologically significant sites.

6.8 Shoreline Erosion. Shoreline erosion is an on-going process at the two lakes and was increased by the pool change of 1980. Extending summer pool would lengthen the duration of wave action on bank faces making them more susceptible to erosion. Other cumulative stressors include land development around the lakes that lead to erosion from reduced buffer areas, overbank runoff, and increased boating (more wave action). Resources potentially affected include cultural resource sites, NWR facilities, lowland and upland habitats, aquatic habitat and private lands. Increased bank stabilization efforts may reduce these effects in more significant locations but would be very expensive to implement on a large scale.

6.9 Cultural Resources. Islands and shoreline terraces have a greater density of cultural resource sites than many other types of areas. Some of these sites have previously been stabilized to reduce bank erosion from endangering the site. However, the vast majority of cultural resource sites are unprotected from bank erosion. As discussed in the preceding paragraph, extension of summer pool would lead to increased erosion affecting cultural resources that are near the shoreline. Other cumulative stressors include increased boating activity (more wave action) and funding availability for providing protection of sites. Increased bank stabilization efforts may reduce these effects, particularly in more significant sites.

6.10 Visual Resources. Visual resources would be degraded by the short-duration of the existing proposal due to effects on the natural appearance of many shoreline areas due to changes in wetland vegetation. Other cumulative factors on visual resources include the rate of development of private lake-front property. The extension might increase the rate of development resulting in an incremental loss of natural appearance of the shoreline.

6.11 Flood Control. Additional modeling would be needed to determine the increased risk of flood damages resulting from extended summer pools. Other stressors on flood control include land development in flood prone areas downstream of the dams and climate trends that could trigger more intense development of tropical storm systems, especially during summer. Additional land development upstream of the lakes could lead to more pronounced flood events coming into the lakes as the amount of impermeable surface area increases. The loss of flood storage during the extension would result in some cumulative effect from an increased frequency of flooding in the two lakes and downstream rivers (Tennessee, Cumberland, Ohio, and Mississippi). The increased flood potential could result in unquantified, but substantial, flood damages.

6.12 Navigation. Additional evaluation is required to determine effects on navigation downstream of the two dams. Due to the lack of control structures and the heavy utilization of these reaches, navigation impacts could be substantial. Another stressor on navigation includes alternate transportation costs for commodities that are currently barge transported. Flood control stressors could also make river navigation more problematic

6.13 Hydropower. Effects of extending summer pool on hydropower generation would be negative due to a less flexible power generation ability during the period of the summer pool extension (July 5-15) and by increased frequency of spillway releases due to reduced flood storage capacity (for the period where pools would be above the existing guide curve). Additional evaluation is needed to quantify these effects. Other cumulative limitations on hydropower could result from regulatory restrictions due to cumulative effects on water quality that could lead to violations of DO standards from dam releases. Meeting the water quality standards might require blending spillway releases with hydropower generation during some periods.

6.14 Recreation. Effects of summer pool extensions would provide some positive benefits to late summer recreational uses from the improved lake navigation and extended use of shoreline facilities such as boat ramps and LBL lakefront camp sites. Marinas would benefit from the additional period of higher pools providing increased opportunities for boat rentals. Private access would be extended for many homeowners. These late summer uses would benefit from improved boating conditions, although fuel prices may limit future boating activity. Other year-round recreation uses such as fishing, hunting, and bird-watching would be negatively affected by long-term reductions in their resources (habitat degradation). A detailed social economic evaluation is needed to quantify net effects in more detail.

6.15 Social and Economic Resources. As discussed in previous paragraphs, direct effects on social and economic resources would be mixed. Businesses that benefit from

late summer recreational tourism would see improvements from the improved lake accessibility. Marinas would see improved rentals and sales of food and gas, particularly those with houseboat and larger cruiser boat usage. Property values would see some marginal increase from the current proposal. Tax revenues would increase along with property values. Other cumulative factors for the lake region include general economic conditions, particularly for higher income households with resources to purchase vacation homes. An increase in retirement populations could also lead to more demand for lake front retirement homes. Although not an effect of pool extension, higher fuel costs could also adversely affect recreational spending.

Other businesses associated with year-round lake uses or uses outside of the mid-summer boating season could see a cumulative negative effect from pool extensions, coupled with the other cumulative stressors on resources such as terrestrial ecology or aquatic resources. Marinas that provide rental boats or sell gas and food to year-round fishermen could see a long-term negative effect. Likewise, waterfowl hunting services and uses would degrade over time. Bird-watching has been a growing use and, if migratory birds are affected as anticipated, by both direct effects of pool extensions and other cumulative stressors, this use could decline. Also, flood damages and hydropower losses would have some cumulative negative effect, although additional evaluation is needed to determine and quantify the full effects.

6.16. Future Projects. As discussed in the introduction to this section, accurately predicting future conditions leads to a great deal of uncertainty in evaluating cumulative effects. One point that has been made several times in this EA is the scope of the current summer pool extension proposal. Many responses to the scoping notice as well as letters and newspaper articles on the issue of summer pool have requested changes in pool management that are well beyond the current proposal. For example, the organization Kentucky's Western Waterland has recommended (see letter in Appendix 16) summer pool be held until August 1 and the drawdown to winter pool be delayed through the fall months. Regardless of any decision on the current proposal, future requests for additional extensions are anticipated.

Other responses to scoping on this issue have requested changes in pool operations that go back to the original guide curve (summer pool held until June 15). These responses are based on observed impacts from the pool change that was made in 1980. Trial operations that restore the original guide curve have been suggested to allow evaluation of impacts on natural resources. The logic is to see if resources benefit from shorter summer pools before subjecting an already stressed system to longer summer pool trials.

The Corps of Engineers is initiating a broad public and private team to discuss and implement potential efforts to address navigation and recreational boating concerns through means other than pool level changes. This could involve possible localized dredging projects on secondary channels or extensions of problem boat ramps or better marking of boating hazard areas. This could address some of the negatives associated with the existing guide curve without subjecting resources to many of the incremental effects described above.

6.17 Cumulative Effects of Selected Alternative. The selected alternative of this EA is a continuation of the existing operation (No Action) coupled with development of baseline data on critical resources such as wetlands and mudflat habitats. Other small scale projects that do not require pool extensions could be implemented to improve recreational boating conditions. These may be subject to additional evaluation under NEPA once the nature of the proposed activities is known.

Section 7 Agency Coordination and Public Review

This EA would be made available for public and agency review for a period of three months. A Notice of Availability of the EA would be distributed and the document would also be available via a Corps web site. Hardcopies would be provided upon request. This extended review would allow wide distribution of the document and avoid some of the perceptions that certain seasonal lake user groups are not allowed an opportunity to review and comment on the issue. The EA would be made available to a variety of lake users groups, in addition to the various resource agencies in Tennessee and Kentucky with an interest in the two lakes. At the conclusion of the review period, comments would be evaluated and the EA revised as warranted.

Section 8 Conclusion and Future Actions.

8.1 Recommendation of this EA. As discussed in Section 3.4, No Action or the continuation of the existing operation is the Corps Recommended Alternative. This recommendation was based on a comparison of the environmental effects and benefits of extending summer pool past July 5. Sensitive habitat areas in the lakes are marginally productive with the existing drawdown date and recreational interests are able to utilize summer pool levels through the early summer. The current drawdown date of July 5 appears to be a good balance of all lake uses without managing for just one user group.

8.2 Baseline Data Collection. As mentioned earlier, TVA committed to developing better baseline data on certain environmental conditions in Kentucky Lake as part of their ROS EIS. The Corps has committed to developing similar information on Lake Barkley. Since lake levels have been an on-going issue for many years, development of more detailed baseline data on wetlands, mudflats, and shorebird/waterfowl use in the two lakes is recommended. This data collection effort is anticipated to take at least until 2008.

8.3 Other Actions Not Related to Lake Levels. The Corps has been tasked to evaluate actions to improve recreational boating conditions in Lake Barkley that do not involve pool levels changes. The Corps' Lake Barkley Resource Management Office will initiate development of a team of people from a variety of lake user groups and government agencies to develop and implement these types of actions. It is envisioned that NEPA coverage for these types of actions would not be controversial, although each action would be evaluated for NEPA compliance on a case by case basis. Actions that might be

suggested include localized dredging to remove a small hazard or to improve access to a boat ramp where use is hindered by lower pool.

8.4 Future EIS on Lake Levels. Because of the potential for significant impacts from extending summer pool on Lake Barkley, if extensions of pool levels are pursued an EIS would be required. If an EIS is prepared, it would evaluate all reasonable and prudent actions, including reverting to the original guide curve and pool extensions of longer duration than July 15. Mitigation efforts and costs would be developed for alternatives considered in detail. Probable mitigation actions associated with pool extensions include capital and operational costs for the NWRs, stabilization efforts for cultural resources sites, habitat restoration projects for development of mudflats, flood control and hydropower impacts. Funding for an EIS and associated mitigation costs would have to be developed since this is outside of current Corps budgets.